THE
ENGINEERING MAGAZINE
VOL. XVII. MAY, 1899. No. 2.

THE MONITOR, THE BATTLE-SHIP, THE CRUISER, AND THE DESTROYER.

By G. W. Dickie.

HAVING treated, in the preceding paper, the heavier fighting units of the navy, it remains to discuss the lighter types—the cruiser and the destroyer. Both of these—unlike the monitor, which is almost distinctively American—are common to the navies of the world.

THE CRUISER.—Most navies have two types of cruisers, armored and protected. The armored cruiser in the great navies now equals the largest battle-ships in displacement, and in fighting qualities is not much behind them. At the same time, as already pointed out, the battle-ship proper has lengthened and become fine enough for eighteen or nineteen knots, and these very heavy ships will maintain their speed under conditions that would compel smaller ships to slow down. It does not appear necessary, therefore, to build a class of cruiser that is as expensive as a battle-ship, while not so strong either for offence or defence, and at best only two knots faster. I believe that the armored cruiser and the battle-ship will in the near future merge into each other, the result being a vessel having the best qualities of both.

I think that in action the new high-powered cruisers, fitted with water-tube boilers, will be in danger from the number of smoke pipes, usually four, the shooting down of any of which would interfere seriously with the working of guns and the ammunition service.

The protected cruiser seems to be the ideal vessel for cruising purposes. Experience indicates that these should be of two sizes,—say, of four thousand and six thousand tons' displacement. Of the latter

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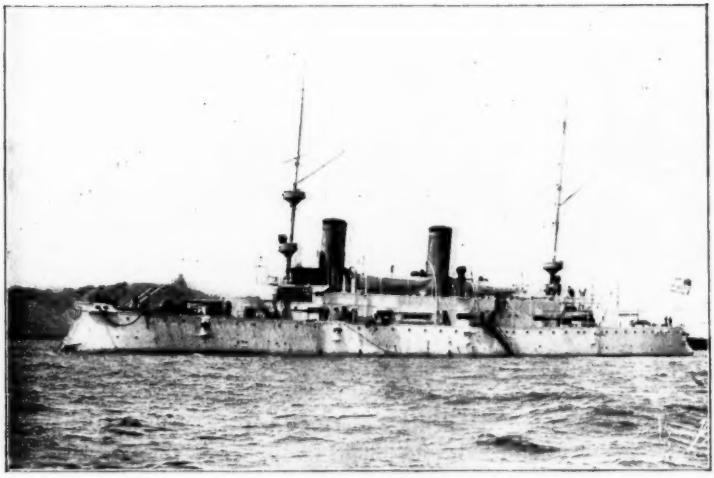
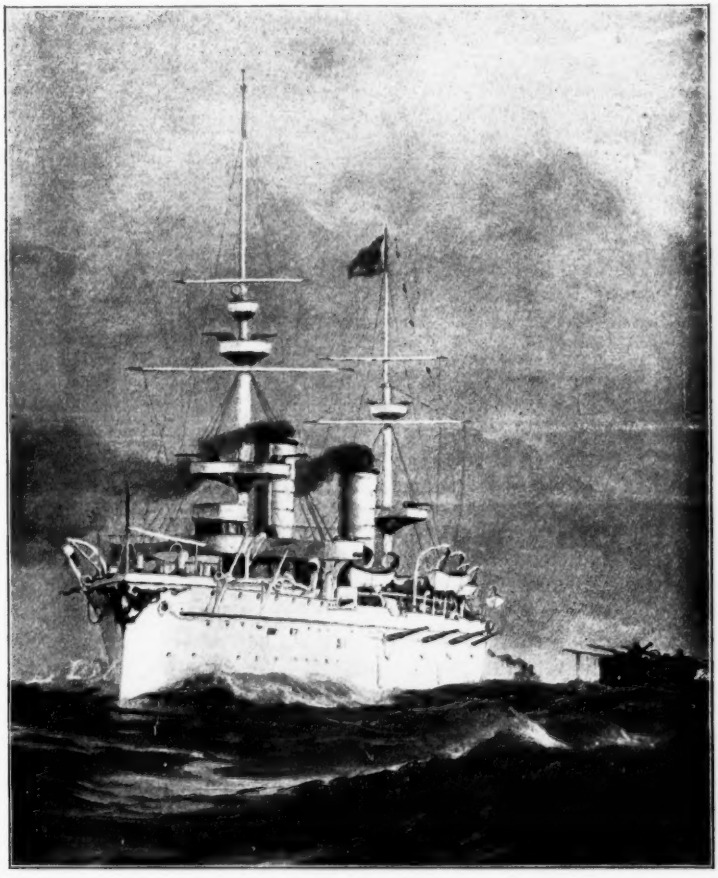


U. S. CRUISER OLYMPIA—5,800 TONS, 17,360 I.H.P.—DEWEY'S FLAG-SHIP.

size the Olympia is the only one in the United States navy. There are, however, a number of the former size, and some that are larger than the Olympia, the latter class including both armored and protected cruisers. I think, however, that the generally-expressed opinion of naval officers is in favor of six thousand tons for the larger class of protected cruiser, and four thousand for the smaller class, both to have a maximum speed of twenty-two knots.

TORPEDO-BOAT DESTROYER.—I have some doubt as to whether this type of vessel has been properly named. It depends upon the meaning attached to the word boat. If the meaning is a torpedo boat intended to destroy other torpedo boats, the name is not so terrible. But, if it means a torpedo boat whose business is destruction in general, then the name accounts for the dread that great war-ships have had of them. The United States had no boats of this class during the late war, and, although the Spanish had some that were considered very good, they evidently lacked the skill or courage to use them, so that nothing has been learned as to value, either for offence or defence, of this type of fighting machine. In a paper read before the Society of Naval Architects and Marine Engineers at the last annual meeting in New York, I endeavored to point out what, in my opinion, are the chief characteristics required in a sea-going torpedo-boat destroyer. That these vessels must be considered as sea-going is ad-

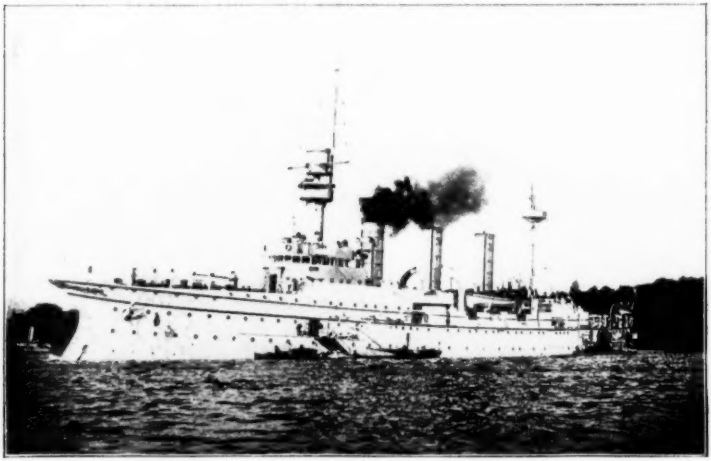
mitted, since the place assigned them in a naval expedition is with the attacking force, their duties being to guard against torpedo-boat attacks from shore, and to keep the large ships informed as to the whereabouts and evident intentions of the enemy. They must be able to do this in all kinds of weather, must have considerable fuel endurance, and must have more speed than protected cruisers. Can it be said that the present type of so-called torpedo-boat destroyers meets these requirements? A majority of these destroyers, when in



ITALIAN CRUISER CARLO ALBERTO, 6,500 TONS, 13,000 I.H.P.

good order, meet the requirements in the matter of speed for short distances in smooth water. But this one quality of speed has been made so paramount to all other qualities that the full speed can be reached only when the conditions are such that the sea-going qualities can be neglected.

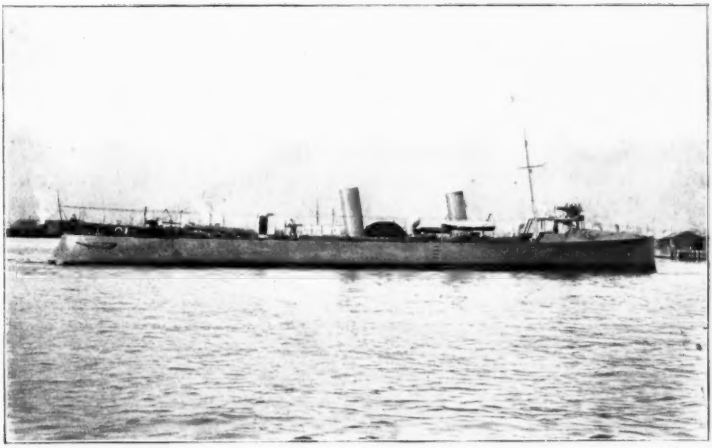
If we consider the conditions of service for such a vessel, stationed on the Pacific coast of the United States, we find that, though these conditions do not differ in kind from those that prevail on the Atlantic



GERMAN CRUISER HERTHA, 5,650 TONS, 9,000 I.H.P.

seaboard, the adverse conditions are far greater. The great distance between harbors on the Pacific coast, and the almost constantly rough water along the coast from Point Conception on the south to Cape Flattery on the north, with only one harbor, render it necessary for any vessel, for practical service outside the harbor of San Francisco or the smooth waters of Puget Sound, to have good sea-going qualities and to be able to remain outside in all conditions of weather.

The qualities necessary for such a service are not possessed in any degree by the present torpedo-boat destroyers. While they have made voyages of considerable length at sea, they have done so usually under the care of a larger vessel, and, while doing so, they have needed extra care, both in watching the weather and taking advantage of every shelter that lies in the way. If the destination is reached without mishap, it is something to be proud of as an achievement en-



U. S. TORPEDO BOAT DESTROYER ROWAN, 276 TONS.

tirely outside of the service for which the vessel is fitted. During such movements these vessels have to be stripped of all their armament to render them possible.

Now, such a vessel in commission on the Pacific coast cannot go from San Francisco harbor to any other harbor without making an ocean voyage of several hundred miles, during which it probably will encounter rough weather.

The 420-ton destroyers lately ordered by the United States government are an improvement on the usual type, but we must go a good deal further in the same direction to obtain a vessel meeting all the conditions that such vessels must meet in sea service.

Recent acquirement of territory by the United States makes it necessary that such vessels for their navy shall have a much greater radius of action, and shall be treated differently. In fact, if a speed of thirty knots or more is aimed at, a sufficiently stanch sea-going vessel cannot be produced in the present state of the art. To obtain thirty knots with the boats now credited with that speed, a supreme effort under expert management is required, which is seldom repeated in the life of the boat.

If the thirty-knot torpedo-boat destroyer's machinery were more substantial, so that full power could be exerted at any time without risk, and if the hull were sufficiently strong to stand a moderate sea without danger, its speed would be about twenty-seven knots. Yet I

venture to say that such a boat, if ordered to reach a point at sea, say, one hundred miles distant, would, under ordinary conditions, reach that point in less time than would be required by the regulation thirty-knot boat, which is said to get a horse power with less than fifty pounds of machinery.

Below I give specifications for a torpedo-boat destroyer adapted for sea service, and fit to accompany a fleet without being a source of care and anxiety to the large vessels. An outline sketch drawing is also given, showing how I would embody the necessary qualities in a sea-going vessel:

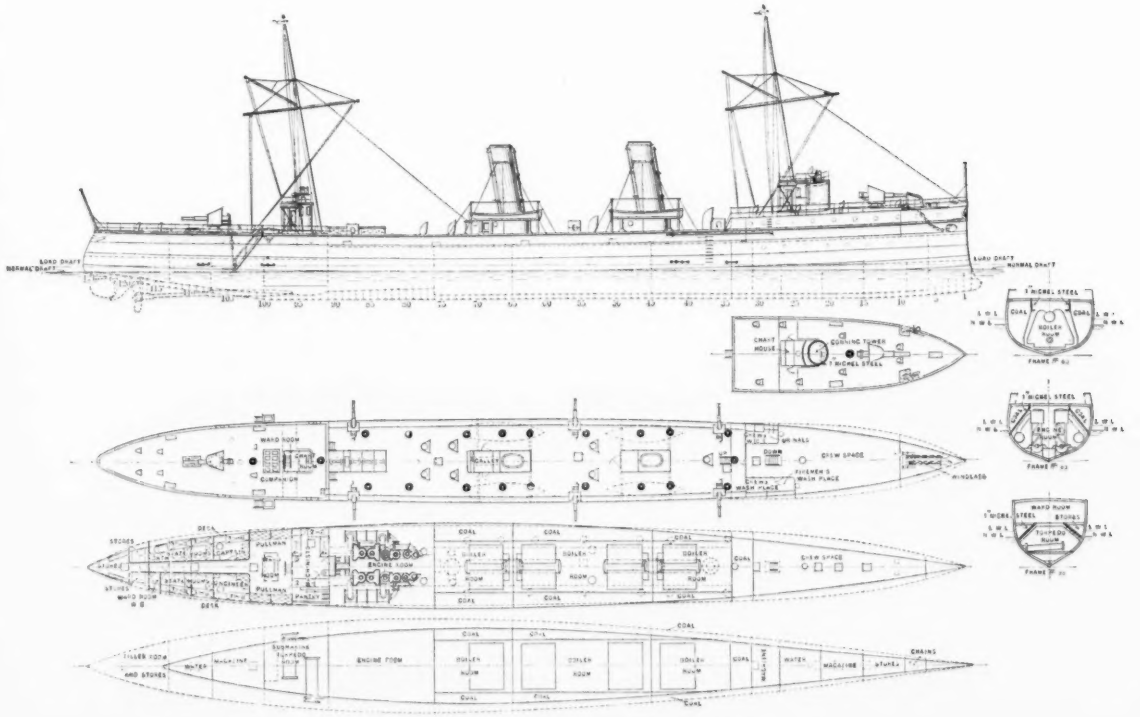
Length on normal water line	250 ft.
Extreme width	25 ft.
Depth moulded	15 ft.
Draught of water on trial	8 ft.
Draught of water loaded	9 ft. 5 ins.
Displacement on trial	640 tons.
Total displacement	800 tons.
Indicated horse power on trial	7,000
Speed on trial, average six hours	25 knots.
Radius of action at 12 knots	3,200 knots.
Speed possible from San Francisco to Honolulu	15 knots.
Speed possible from San Francisco to Puget Sound Naval Station or San Diego, moderate weather	20 knots.

The weights provided for are as follows:

Ordnance	36 tons.
Machinery, including water in boilers, etc	230 tons.
Hull complete, and fittings	300 tons.
Crew and effects, including portable furniture	14 tons.
Coal at normal trim	60 tons.
Making the normal displacement	640 tons.
Coefficient at 8 ft. draught	.448

With bunkers full of coal, there would be 160 tons more, the full coal capacity being 200 tons.

I have designed this vessel with a full forecastle extending to the forward fire room and a half poop extending to the engine room. Between the poop and forecastle a hammock berthing extends the full length. This arrangement would give very good quarters, both for officers and crew. The vessel would carry two 4-inch rapid-firing guns, one on the forecastle deck and one on the poop. The 6-pounder guns, of which there are six, would be carried on rail mounts above the hammock berthing. Castings around the two smoke pipes are carried high enough to take the inner ends of the boat skid beams.



PROPOSED SEA-GOING TORPEDO BOAT DESTROYER.

This enables four boats to be carried, with head room under them, while the casings furnish room for the galleys on deck. The conning tower is of one-inch nickel steel. There is a chart house aft of the conning tower, and a bridge above. There is also an after steering house on the poop. This covers the stairs to the officers' quarters, and carries the search-light above. This light would be controlled from the forward bridge, although I believe that control from a distance for search-lights is not in so much favor now as it was formerly. The machinists, or engine-room artificers, as they are termed in England, would occupy a space at the forward end of the poop, entering from the landing leading to the engine room, aft of which would be the ward room and officers' state-rooms. The total complement of officers and crew would be seventy-five.

I have purposely omitted all deck torpedo-launching tubes, believing that they should form no part of the armament of a sea-going torpedo-boat destroyer. The deck tubes, if there was any intention to use them, would contain charged torpedoes, which, in action where many ships might be engaged, and in so exposed a position, would be a source of dread to those on board. I have therefore arranged for two special submerged torpedo tubes in a protected compartment aft of the engine room. Owing to the limited width of such a vessel, these tubes would be designed to open on top, instead of at the inner end. I believe that there is no mechanical difficulty in so designing discharging tubes and the impeller that carries the torpedo clear of the skin of the vessel before release, as to admit of the torpedo being placed in the tube from the top side.

The sloping sides of the torpedo room would be of one-inch nickel steel. One-inch nickel-steel protection extends also the whole length of the engine and boiler compartments, giving a moderate amount of protection when the coal bunkers are empty.

In this design I have aimed at a sea-going torpedo-boat destroyer that can go to sea and remain there, without any special risk, and can maintain there a speed of twenty-five knots for a few hours when such a speed is required; that can make extended voyages, thus serving the purpose of a scout or dispatch-boat whenever or wherever such service is required; and that carries a battery which makes her a torpedo-boat destroyer in fact. Such a boat would, I believe, meet the service conditions that will surely be demanded when the present type of boat has been put to the test of sea service.

THE POSSIBILITIES OF LIQUID AIR.

By Elihu Thomson.

AT the outset it must be understood that in dealing with the present subject the writer does not wish it to be inferred that what he calls possibilities are in his judgment probabilities of the near future, or, that we are upon the eve of any great revolution in engineering methods as the outcome of the recent laboratory studies of liquid air. Much further study and much additional data are required before anything more than mere suggestion can be made in this fascinating field; for, say what we may, the subject possesses an attraction for those who are accustomed to look ahead, remembering that the laboratory experiments of one day and generation have often in the past become the foundations of great industries. It took three-quarters of a century for Davy's electric arc to develop into the beginnings of commercial arc-lighting, and nearly fifty years elapsed after Faraday's brilliant researches in magneto-electricity before dynamos became a part of engineering. Yet Faraday had built a primitive dynamo and its reversed form was known in primitive types of electric motor.

Who would have supposed, when ammonia gas was first liquified by pressure, that before the close of the century companies would be doing business by sending it about in pipes for refrigeration? Yet such is the fact.

The splendid studies in liquid air and other gases carried on by Professors Dewar and Fleming, on the very spot where Faraday had made his memorable researches in the liquefaction of gases, form a fitting sequel to the work of that great pioneer.

The object of the present article will be to suggest rather than predict directions in which, under certain conditions, liquid air may possibly become a factor in engineering. And in the absence of favorable conditions need it be said that such possibilities will *not* be capable of realization?

Let us assume the availability of some innocuous gas liquefiable at about one hundred atmospheres pressure, at temperatures easily and cheaply attained, and at no cost for the gas itself. In such a case there can be no doubt of its soon finding enormous application in the storage and recovery of energy. Cheap power would be used to com-

press and liquefy it, after which it would be stored in quantity, either at atmospheric pressure or at some selected higher pressure. Such a liquefied gas would be stable, or remain in the liquid state, if heat were prevented from reaching it. This could be done, not perfectly of course, by surrounding the containing vessel with a liberal thickness of some good non-conductor of heat. That part of the gas which would inevitably escape on account of the lack of perfect heat-insulation would be cold and would be made to traverse the non-conducting covering in successive layers from within outward, and thus assist in cooling the covering and in preventing access of heat to the liquid; or, the escaping gas might even be made available for power in an engine, if the liquid were kept under a proper working-pressure. In this case further heating of the gas, analogous to superheating of steam, could be employed before sending it to the engine. But little of the energy of the heat so added would be lost, and a considerable part of it could be supplied by the surrounding air or by water.

With such a liquefied gas produced at one place by cheap power and carried to another for evaporation and recovery of power, ice could be made as a by-product.

In many plants used for the development of power on a large scale, a twenty-four hours' output is not called for, but could be attained at but slight additional expense. The excess power from such a plant needs some means of utilization. This excess power, as during periods of otherwise light load, could be employed to liquefy the assumed gas. On a large scale this procedure would not be costly, supposing the use of highly developed machinery. The liquid product could then be transported in tanks provided with heavy lagging and special arrangements to prevent access of heat from the outside. Perhaps it could be distributed by a well-covered pipe-line. The unavoidable evaporation which would be involved in the pipe-line transportation might not be altogether a loss, for if the line be under a pressure suitable for engines the escaping gas might possibly be tapped out at intervals, heated, and used for power along the line of way.

But the foregoing considerations are based upon the existence of a gas at no cost, with desirable properties rendering its liquefaction easy. Such a gas does not in fact exist. There then arises the question whether we can render available any of the gases known to us. Carbonic-acid gas is cheap, but still far too costly for use in the way proposed. It would not pay to send it back long distances for recom-

pression and reliquefaction. It costs too much to be thrown away after it has been once used.

The air itself meets the condition of no cost for material in the case. We owe much the larger part of our present knowledge of the properties of liquid air to a brilliant series of investigations undertaken some years ago by Professor Dewar at the Royal Institution in London, and continued later by Professors Dewar and Fleming conjointly. The effects of the exceedingly low temperature attained by the evaporation of liquid air, upon electric conductors, dielectrics, electrolytes, etc., have been carefully studied by them. Few are able to appreciate the labor and painstaking effort that must have been expended in these researches.

In culmination, Professor Dewar has indeed lately succeeded in reducing even hydrogen to a liquid and in collecting quantities of it. Temperatures not far removed from absolute zero (—273° C.) are obtained by the evaporation of liquid hydrogen. But the absolute zero, like the dynamo of 100 per cent. efficiency, may by each advance be more and more closely approximated but never reached. This low-temperature research has shown that at temperatures as low as —200° C., attainable by evaporation of liquid air, conducting-metals, as copper, platinum, silver, etc., when in a very pure state, have their conductivities so much enhanced that electric currents flow with but a fraction of the resistance experienced at ordinary temperatures. Research has shown that at absolute zero they would become perfect conductors. Professors Dewar and Fleming also found that liquid air is a very perfect insulator, and that ice and many frozen electrolytes even become excellent insulators at the temperatures of liquid air; and in general that intense cold in insulators improves the insulation, just as it improves the conductivity of conducting-metals when they are pure.

Unfortunately, however, the liquefaction of air requires rather extreme conditions, and in the early work of Dewar was an exceedingly costly process.

The discovery of the fact that air compressed, cooled, and collected in a reservoir at from 100 to 150 atmospheres might be made to liquefy a portion of its own volume, rendered possible the procuring of liquid air by a more direct and simple means. This discovery is claimed by several persons, the merits of whose claims will not be here discussed. When highly compressed air escapes from a suitable orifice it is cooled by its own expansion. If the cooled air be now caused to circulate around a long coiled pipe, which brings the compressed

air to the jet in such a way that the portion of pipe nearest the jet is the first to be met by the cooled air, and so back progressively from the jet; further, if the whole be thoroughly jacketed by a non-conducting covering, the temperature at the jet soon falls sufficiently low to cause liquefaction of a portion of the air even at ordinary atmospheric pressure. The operation itself is cumulative or self-intensifying, since the cooling due to expansion is employed, on the regenrator principle, to cool most effectively the compressed gas on its way to the jet and ready to expand.

If air be compressed to about 800 atmospheres it may be made to occupy the same space as it does when liquefied, but even at higher pressures it would remain gaseous. Ordinary temperatures of the surrounding air are far above the critical temperatures of the gases composing it. In order that it may liquefy, it must lose kinetic energy or be cooled; the velocity of the moving molecules must be brought down. The removal of heat is essential, and the process of liquefaction can only be carried on by cooling the gas during or after compression. Conversely, liquid air confined in a closed and filled receptacle, when allowed to regain the heat lost in being liquefied, would become gaseous and exert a pressure of about six tons per square inch.

That the processes for producing liquid air will be developed so as to reduce the cost to an extent such as to render it available in place of a more ideal gas would be a vain prediction to make at present.

Liquid air consists chiefly of a mixture of four parts of nitrogen to one of oxygen. The presence of the oxygen is a disadvantage, inasmuch as fierce combustion, if not explosion, may be occasioned by bringing liquid air into contact with combustibles in presence of a spark or fire. Fine cotton fibre and suchlike substances soaked in liquid oxygen are highly explosive. It is easy, however, to separate the oxygen from the nitrogen by fractional distillation at low temperatures, or methods may be employed to condense the oxygen separately from the nitrogen. Doubtless, oxygen gas so separated from its companion would have a value in chemical and metallurgical processes. The remaining nitrogen liquefied would be perfectly safe. Can it be transported?

The fact that a three-gallon milk-can of liquid air was brought by Mr. Tripler, of New York, from that city to Lynn, Mass., a journey occupying nine hours, and that not more than one third of the liquefied gas was lost, although the only covering for heat-insulation was about 2½ inches of ordinary steam-pipe felting, goes far toward

indicating the possibility of transportation. With a tank of 20 times the linear dimensions of the milk-can referred to, the surface for loss of heat would rise to 400 times while the capacity would have increased to 8,000 times, and with no better lagging it is easily seen that the daily loss would then be not over 5 per cent. Doubtless, however, improved means for heat-insulation would make the loss but a fraction of this amount. If the tank were kept under a pressure of, say, 200 pounds to the square inch, a suitable safety-valve being provided to prevent excess of pressure, the evaporated gas or air could be made to do work, especially if superheated. If the tank were in a train the motive-power might, at least in part, be derived from the normal evaporation from the tanks. Further, let us imagine a pipe-line well insulated for heat, and it is easy to see that if the velocity of flow equalled the train-speed in the journey of the milk-can from New York to Lynn, the percentage loss in a pipe of the diameter of the milk-can with no better lagging than it possessed would be the same or even less. Here again perfection of heat-insulation might make quite a saving, and the evaporated gas might, if the line were under pressure, be made available for power along the line of way.

Whether the liquefied gases of the air can be employed in this way, will, however, depend upon the development of efficient methods of extracting the heat and effecting condensation of the air. That liquid air possesses no advantage for refrigeration is without doubt true, unless the refrigerating effect be obtainable as a by-product, so to speak, of energy conveyance.

Liquid air represents air compressed to about 800 atmospheres, but existing without pressure. No heavy and excessively strong tanks are needed for storing it. If it be pumped into a closed receptacle under regulated pressure it may be evaporated by the heat of the air, or that of surrounding objects, or it may receive heat from bodies undergoing refrigeration, as water being converted into ice; after which heating operation it may be further heated to the melting-point of lead by heat of combustion, and be finally used in a suitable engine where its expansion may develop power. During its expansion and delivery of power to the pistons of the engine it may become so cooled as to be discharged from the exhaust at nearly normal atmospheric temperature and pressure.

The power expended in compressing and liquefying air is, of course, converted into heat and thrown away. The product, liquid air, has no inherent power of energy in itself. It represents negativity, bearing somewhat the same relation that an exhausted globe does to the

surrounding air. It may become the means for rendering the normal energy in the surrounding air available. Liquid air has capacity for taking up the ordinary heat of surrounding objects and thus acquiring pressure. It can be superheated very efficiently, and so used in the form of compressed air in an engine. The superheating will, of course, tend to raise greatly the total efficiency. The inevitable losses in the compressing and liquefying processes would in part be made up in the added heat, the amount of which is small and efficiently employed. We have no reliable data of large-scale operations, and can as yet reach no certainty as to the efficiency attainable in compression and liquefaction or in recovery of power. It is possible that the separation of oxygen, which would probably possess a value in metallurgy, might tend to diminish the cost of condensation. So also the refrigeration which is obtained during evaporation might help the recovery end. Where so much is "in the air" we must be content with suggestions only, and they may never be realized in practice. The power required to be expended in liquefying a given amount of air can be approximately estimated, and an assumed efficiency of plant may be made to do duty in place of exact figures where none are to be had, and if the conclusions based thereon are understood as tentative and subject to extensive modification in view of further advances in our knowledge, no harm is done.

In making an estimate of the cost of liquid air as produced on the large scale, the factors of plant-efficiency, maintenance, etc., come in to a greater or less extent. Assuming that air be compressed as nearly isothermally as possible, and that in a large plant a possible total efficiency of seventy per cent. might probably be realized, each horse-power hour might thus be expected to compress nearly 10 pounds of air to a pressure of 2,000 pounds to the square inch. If such compressed air, on being expanded in a very carefully arranged self-intensifying apparatus should condense 25 per cent. of the air admitted we would have about 2½ pounds of liquid air per horse-power hour. The assumed proportion, 25 per cent., seems not improbable in view of all the data—meagre enough, it is true—which have come to the writer's knowledge.

If the power-cost be taken at $20 per year in large units and an additional charge of $10 be allowed for each horse-power of the compressing and condensing plant, its interest, maintenance, and operating expenses, the cost per pound of liquid air would be about one sixth of a cent, assuming the plant to run 7,200 hours per year. This estimate, subject to modification from the very nature of the problem, would

make the liquid air cost for production about 8 cents per cubic foot. If oxygen, separated by fractional distillation possessed a value for equal amounts in excess of the cost of the air the remaining nitrogen would, of course, be producible at a lower figure.

It is probably within the possibilities that a cubic foot of liquid air or nitrogen, if allowed to heat from its surroundings and then be further heated to 200° C., could, in a high-pressure engine, yield about five horse-power hours. If at the same time the vaporization of the air were attended by useful refrigeration, as in making ice, the cost of recovery would diminish. Need it be said here, however, that even if the cost of horse-power of recovered energy much exceeded that which is indicated in the foregoing estimates or assumptions, a demand may still exist for a source of power having great compactness, freedom from nuisance, no heated nor noxious exhaust, and of unequalled controllability? The horseless-vehicle problem certainly presents us with an instance in point.

It would seem, however, that certain uses may be found for liquid air in which considerations of cost are not so important as is the ability to obtain the effects in view. In warfare, for example, the possession of highly concentrated energy-stores under control is very important. Liquid air can be rapidly converted into compressed air at six tons per square inch. This would probably be useful in the projection of high explosives. Compressed air is now used for propelling mobile torpedoes, or fish-torpedoes as they are called. Dirigible torpedoes either depend for power upon compressed air or the electric energy of a storage-battery. Compressed air requires high pressures and very strong and heavy containing-vessels. Liquid air can be stored without pressure or at low pressures, and can be evaporated at any desired pressure, while its bulk represents that of air under 800 atmospheres. A storage battery would probably be from five to ten times as heavy as liquid air in a receptacle, for equal available energy. But no storage-battery could be discharged at an equivalent rate.

Submarine boats and flying-machines may yet find use for liquid air. In the submarine boat it could be evaporated by the heat of the surrounding water, and after furnishing power it would ventilate the boat. Before its final discharge it could be burnt with oil in a fuel-engine for further power. We may find use for it in the flying-machine. For emergency work it could in evaporating cool the cylinders of a fuel-engine and yield power as a result. Moreover, control of the submergence of a boat could be effected by the use of liquid air, so easily gasified, to add to the displacement.

The great feature of the application of such a power as liquid air would be its emergency value. By this is meant the ability to obtain at will a sudden output far beyond the normal. Animal power notably possesses this emergency value, and the success of electric trolley systems largely depends upon the fact that, when needed, the station can be called upon for a temporary delivery to any single car or train, of a power greatly in excess of the rated output of the motors.

Suggestions have already been made of the use of liquid air or oxygen, mixed with combustibles as a high explosive. Such an explosive can be made at the time of use, and if left unexploded, either by accident or design, soon loses its dangerous character by evaporation of the liquid gas.

Liquid air may also be used in the rapid production of high vacua. Let the bulb to be exhausted be filled with a gas, such as carbonic acid, more condensible than air, and be provided with an extension that can at any time be sealed off. If now the extension-piece be immersed in liquid air the condensible gas will be taken from the bulb and deposited in the solid state in the extension-piece. This is now sealed off, leaving a high vacuum in the bulb, particularly if the same be heated during the process.

A fascinating speculation for the electrical engineer is the possibility of so cooling the conductors of electric lines or apparatus as to improve the conductivity many times, and so diminish the losses in any given length of conductor, and at the same time greatly improve the insulation. Professors Dewar and Fleming have shown, however, that it is a condition of this enormous improvement in conductivity that the metals be very pure, a very small percentage of impurity greatly lessening the result. As regards the insulation, they have shown that dielectrics and even electrolytes become insulators of excellent character when cooled to the temperature of liquid air. What effect such a lowering of temperature would have upon the dielectric strength or striking distance between conductors at great differences of potential is not as yet determined, so far as the writer is aware. The result to be expected from a consideration of the effect of heating upon dielectric strength or striking distance is that very low temperature will make it far more difficult to break down insulation by sparking through it.

That the electrical engineer covets just such agencies as will thus extend the range of possibilities in his art needs no proof. He would be apt to choose a pipe-line conveying liquid air as the very best location for his conductors, assumed to be made of as pure metal as

possible, the high insulation probably attainable being the chief object. Whether his conductors were placed outside such a pipe or within the same, he could no doubt adapt himself to the conditions, provided he could get the benefit of the low temperature insulation, and possibly, to a certain extent, a gain in conduction.

It is indeed very questionable whether a pipe-line will ever be laid and kept filled with liquid air solely for its electrical benefits, but if such a line were also used to supply liquid air to a distant point and the normal evaporation utilized, the case would be somewhat modified, though the improbability of such a combination being put into service, at least within any reasonable period, still remains.

It will be the proper attitude for the conservative and at the same time progressive engineer to await the possession of full and accurate data before drawing any conclusions as to future practice. Suggestions of possibilities are, of course, useful, even if only a fraction of them prove realizable, and no attempt is here made to do otherwise than call attention to matters which must from their nature possess more or less of interest.

CENTRAL-STATION PRACTICE IN GREAT BRITAIN.

By H. Cuthbert Hall.

ELECTRIC lighting from central stations was removed from the domain of scientific speculation to practical politics by the invention of the high-resistance incandescent lamp, which was the outcome of the recognition of the principle that the distribution of electricity must be at constant potential, with lamps working in multiple arc.

Since the date of this invention (1880), lighting from central stations has progressed with great rapidity; but in England, perhaps more than in any other country of the world, restrictive legislation has acted as a deterrent to persons desirous of undertaking the public supply of electricity. The tendency of the legislature has been to impose conditions which primarily are for the protection of the public rather than as little restrictive as possible to a great industry enormously for the general advantage. The act of 1882, which gave local authorities the option to purchase at the end of twenty-one years the electric-lighting undertakings of public companies supplying current in their areas, by reason of this clause offered no special inducement to companies to put down a supply-station. At that time, when public lighting by means of electricity was still almost of an experimental nature, it was particularly desirable to encourage private, as opposed to municipal, enterprise. The lighting of private houses and small groups of buildings with electricity had been demonstrated not only an engineering, but a financial, success; but, although these plants provided engineering data on which to base calculations for central stations for the public supply of electricity for large areas, they afforded little or no criterion of the profit likely to be derived from such undertakings. The twenty-one years' clause having proved restrictive of private enterprise, in 1888 a bill was brought before parliament containing many important modifications of the previous bill, but principally a clause by which the limit of time for which the supply company could retain control of its undertaking, without the liability to be bought up by the municipality, was placed at forty-two years. The results of these important modifications were seen at once in a large number of applications from public companies to Parliament for the

right to supply electricity in the various towns and cities of the kingdom.

About 1895 two large companies were formed, each desiring to promote bills empowering them to supply current not to private consumers, but in bulk to supply-companies, which would distribute the current to the private consumers. These companies were, in a word, to be wholesale suppliers of electricity, supplying large quantities to a few big customers, rather than small quantities to numerous customers, as is the case with the ordinary supply-company.

All this is matter of history, but it is very important in showing the influence of legislation on electric lighting, or, to speak more accurately, as showing the central-station practice which experience has proved the best, and which has resulted in, or promises to result in, a special form of legislation.

Electric-lighting legislation in England generally may therefore be regarded as the outcome of expressed engineering experience. On the other hand, certain details of legislation make for the adoption of special methods of supply of electricity which are not in themselves inherently the most advantageous, but which may be necessitated by the course adopted by the legislature. Particularly is this the case with regard to the location of central stations outside the area to be supplied. The act of 1888, by giving statutory powers to electric supply-companies to acquire land compulsorily for the erection of central stations, has not exempted them from actions for damages to neighboring buildings from smoke, vibration, and other forms of nuisance. True, it has been laid down that, where such statutory powers have been conferred, the company can not be shown to have been guilty of nuisance, unless it be proved that it has not adopted reasonable means for the prevention of such a nuisance; but, practically, the operation of the act is that, where any engineering devices exist, which, however expensive, tend to reduction or elimination of the nuisance in question, the company which does not employ them is guilty of negligence. The practical outcome of this has been that in several cases (*e. g.*, the Chelsea Electric Supply Company), in order to eliminate vibration, the company was compelled, at great cost, to experiment with different types of engines, until that particular type which was found to give the least vibration had been arrived at. Certain broad principles on which the work should be carried out having received recognition by engineers in every part of the world, attention was devoted to perfecting the details of distribution. Perhaps in no other industrial enterprise is the development of power carried out on lines so highly sci-

entific, the profits of electric lighting being comparatively so meagre that all the details of the generation of power have been brought necessarily almost to perfection.

The experience of Manchester, where current is supplied at as low a rate as 3d. per unit; of Bradford, where it is supplied at 2d. per unit; and of London, where, from the City of London Lighting Company, current can be obtained for certain purposes for 3d. per unit, all demonstrate the high pitch of perfection to which engineering enterprise in connection with the supply of electricity has been brought.

It is not the purpose of this article to deal, in more than a cursory way, with the details of central-station engineering which have contributed to this end, but to discuss those general principles which promise substantial reduction in the cost of electricity in the near future.

Among what may be called the details of central-station engineering which, as experience has shown, materially reduce the cost of supply, principally by reducing the capital outlay, are: (1) the three-wire system; (2) high-speed engines; (3) 200-volt lamps. Early central stations were put down on one of two principles, either low-tension direct-current supply at 100 volts, or high-tension alternate-current supply, generating at 1,000 volts and transforming down to 100 at the consumers' lamps by means of transformers installed on the premises.

The first material advance was in the adoption of Dr. John Hopkinson's three-wire system, which enabled the supply-companies to effect a considerable saving in the cost of copper by doubling the potential at which current was supplied from the station, while it was kept at the same potential at the consumers' lamps.

Recently—in fact, during the last two or three years—the manufacture of incandescent lamps has so far advanced that the 200-volt lamp has passed from a laboratory curiosity to a commercial article, and, while the life of these lamps is still somewhat below that of the 100-volt lamps, the efficiency is greater, which, with the considerable reduction in the first cost of the lamps that has taken place during the last few years, represents an economy in current which may far more than compensate for the shorter life of the lamp and extra cost consequent on more frequent renewals. The introduction of the 200-volt lamp has enabled central stations to double their customers without further outlay for mains, and with very little further outlay for generating plant; so that, by the adoption of the three-wire system, twice as many lamps can be supplied as formerly with a given set of

mains and a given generating plant, and, by the adoption in addition of the 200-volt lamp, four times as many lamps as formerly.

The high-speed engine, although comparing very unfavourably with its low-speed brother as regards cost of maintenance and life, is, by reason of its compactness, and of the absence of connecting gear, cheaper, even in the long run, than the slow-speed horizontal type, and more particularly in those areas where the cost of land is high.

For the lighting of towns no point requires more careful consideration than the special conditions attaching to the town in question; therefore, reasoning from existing central stations in other towns having different conditions is often fallacious. Particularly is this the case with regard to some of the earlier central-lighting stations established in England. Although not universally, yet very generally, the earlier stations were established to serve towns representing the most favourable conditions, on the obvious principle of natural selection. Since that time, however, the details of the generation of electricity have been so much improved, and the particular system suited to a special area has been so well determined by experiment, that there is far more to be learned from the work carried out during the last few years, and more particularly in those towns where the conditions are by no means wholly favourable. Many towns in which electric lighting would have been ten years ago a failure from a pecuniary standpoint are now equipped with the central lighting-station plant, which not only gives an admirable service, but yields a handsome return on the capital invested.

Persons who have never studied the problems of electrical distribution, even engineers of high achievement in other branches of the profession, hardly realize how extremely onerous are the conditions under which the central lighting-station engineer has to do his work. In almost every other branch of engineering where power has to be developed the load is a practically constant factor, whereas the central lighting-station engineer has to provide plant for supplying a very large output for a very few hours of the twenty-four, while the plant which is to provide this output is, for the remaining hours of the day, practically idle and quite unremunerative. Therefore a comparatively small proportion of the plant has to earn a dividend on an amount of capital enormously in excess of that expended on what I may call the earning plant. Having regard to the fact that, despite this great difficulty, central stations which are earning dividends are very numerous, the prospects of the industry when a practically constant load can be obtained are enormous.

It has been suggested that the working of electric-traction systems in conjunction with lighting will solve this difficulty of the load factor. A little reflection, however, will serve to show that this idea is to a large extent fallacious—first, because the traction load overlaps at a certain time the lighting load, and, secondly, because the sudden demand on the plant for lighting purposes, as a result of fog in large cities, is in no way assisted by a constant load during the daytime for traction purposes. Engineers have, therefore, to recognise this fact, that, until the lighting load of a central station represents a very small proportion—almost a negligible proportion—of the total output of current from the station, the load factor can never be a good one. It is of the very nature of lighting that the demand should be constantly varying throughout the twenty-four hours, and liable to change in a few minutes from maximum to minimum load.

A reference to the load curves of any of the large central stations in the different towns of England and America would at once demonstrate the correctness of this statement. As, therefore, the time is yet a long way off when the constant demand on central stations for a current for power purposes will be enormously in excess of the demand for lighting purposes, central-station engineers have to grapple with the conditions which I have indicated above, and which are so onerous upon the undertaking.

We should not, however, in designing a central station for a large town, lose sight of the possibility of a great demand for current arising during the day-time for power purposes, as these are the conditions which in the near future may exist which will enable the greatest revenue to be earned upon central-station plant, and which should be borne in mind with a view to making the original plant of such a nature that it can be economically included with the plant intended to serve different and more remunerative conditions of working.

When a central supply-company is found sufficiently enterprising to put down in, or contiguous to, a large industrial centre a station avowedly for the supply of current for industrial purposes on a large scale at a low price, an enormous demand will be thereby created; and a far-seeing engineer will make it his business to create a demand by providing cheap supply. It has not been sufficiently realised that the supply of current for electric-lighting purposes on the cheapest possible lines is dependent upon making the lighting an adjunct of the supplying current for power purposes, and not the primary object.

Hardly too strongly can be urged the necessity of employing, in

connection with town lighting, a competent and absolutely independent consulting engineer; and, unless recourse be had to the practice which, in one or two isolated instances, has been adopted in Germany—of building the works at the expense of the town, with a contractor's guaranty of interest and depreciation—the construction of a central station, if left solely to the contractors, is likely to be on lines which, at best, would show a profit only for a short time, and will hardly ever be of such a character that advantageous extensions can be made. Nearly all contractors have their special apparatus to sell and advocate, and it is only human nature for each to think that his is best suited for every condition. In central stations carried out on such lines the apparatus which the contractor has to supply is first thought of, and it is fitted in as well as it can be to the particular conditions obtaining; whereas, of course, the conditions should be first considered, and that apparatus selected which is best suited to them.

A point that has to be very carefully considered is the particular system best suited to that part of the area to be supplied from which a dividend may reasonably be expected. Given an area comprising a number of houses situated close together and a smaller number of houses in outlying places, it will be better to put down a system perfectly suited to supplying the thickly-populated district, with a special plant for the outlying districts, than to have a uniform type of plant for the whole area. For, if the highest profit which it is possible to earn from the thickly-populated district be secured, this part will pay for the less profitable outlying districts, and, in fact, compensate for a possible loss in these districts.

A great point to be borne in mind is the impossibility of separating first-cost from working-cost. The initial outlay on one type of plant may be very much higher than on another, but, owing to its adoption, the low working-cost may more than compensate for the interest on the extra capital outlay. On the other hand, the working-cost with mains of a large diameter may be less than the working-cost with mains of a smaller diameter, but the interest on the capital outlay necessary for the larger-size mains may be greater than the saving in working-cost effected by using them. Water-power costing nothing per horse-power appears a much cheaper fuel than coal at 15s. a ton, but if, in order to utilize the water-power, it is necessary to put down mains of great length, costing many thousands of pounds, the interest on the capital outlay in connection with these mains will represent far more than the cost of fuel at 15s. a ton burned at works

in close proximity to the area throughout which current is distributed.

Although, as a general rule, so far as economy is concerned, it is desirable to have the central station as near the centre of the area of supply as possible, special conditions may obtain which justify, and even render desirable, the placing of the station some distance from the centre of supply. At Cheltenham, for instance, the works, which are a municipal concern, are placed about a mile and a half from the centre of the town. This site was adopted because the refuse-destructor is situated in this position, the land is owned by the corporation, and a chimney-stack used for the destructor can be also utilized for the electric-light works. Also, the Midland Railway Company passes so close to the site that coal can be conveyed to the works without carting and unloading. The shaft for the refuse-destructor being already constructed, and there being a 70-h. p. boiler already available, the cost of the works has been kept exceedingly low. As I have said above, where immediate economy alone is considered, it is usually desirable to place the central station as near to the centre of the area of supply as possible. But I feel confident that a time will arrive when central stations will be placed further from the centres of towns, many causes operating toward this end.

The great problem, therefore, which is likely to confront central-station engineers in the near future—one which may influence a radical change in all kinds of central-station plant and an almost complete alteration in existing methods of distribution and generation—is that which I have indicated above, *viz.*, the tendency to put down in certain favourable districts large central stations to supply electricity in bulk; and probably the principal question, in connection with the distribution of electricity, which the near future will solve will be whether it is cheaper to put down a number of isolated central stations in the particular areas to be supplied, or to put down fewer, and very much larger, stations in certain favourable places to supply the current in bulk to distributing stations situated in the centre of the areas which they supply. The advantages of this system of supply in bulk can be seen almost at a glance. In the first place, the difficulty of a good load factor will be thereby partially overcome, for current can be generated for industrial purposes at such a price that there will be a considerable demand. The stations will be put down in places where land is comparatively cheap, and far removed from buildings to which they are likely, by reason of smoke, vibration, or other causes, to constitute a nuisance. In the case of the scheme for

the Midlands, the station would be very favourably situated with regard to the supply of coal. It has been pointed out—and there is no gainsaying the fact—that the cost of carting coal is so low that it is very questionable whether energy can not be conveyed more cheaply in this form than by means of electricity generated in places where coal is very cheap. Certainly this principle applies to the generation of electricity generated by means of water-power; the interest on the capital outlay may be so high as to more than outbalance the advantages of cheap fuel; but, in the case referred to above, the station would be placed not so very far from a considerable number of large towns having extensive manufacturing interests, where demands for improved hygienic conditions are peculiarly exigent. By placing these large stations for the supply of electricity in bulk outside the residential and manufacturing centres, the difficulties which existing central stations in the area of supply now find so serious—*viz.*, actions for nuisances in respect of vibration, smoke, and other causes—would be eliminated, for the existing supply-stations would be converted from stations generating electricity by means of steam to mere distributing stations having only electric motors and dynamos, involving no smoke, and reducing vibration to the minimum obtainable with running machinery.

Certain of the companies, particularly in the west end of London, have found, during the last few years, that the demand for current was going up so rapidly, notwithstanding the introduction of the most economical methods of supply, that shortly their stations will be inadequate. Many of them state that they have been making strenuous efforts, during the last two or three years, to obtain suitable sites for the building of new stations, and most of them also report that these efforts have so far met with but very little success. In fact, in one case they have met with worse than want of success—with positive loss—for the station of at least one supply-company has been actually closed because it constituted a nuisance to neighboring buildings. Again, in the west end of London the mere question of getting coal carted to the station is a very important one. One station alone requires for its daily consumption of coal no fewer than two hundred carts. Two hundred carts carrying coal through west-end thoroughfares every day of the year constitute, unless the traffic is relegated to special hours of the day, a serious nuisance, and when we reflect that this difficulty, rather than decreasing, is daily tending to increase, a case for supply-stations outside the area of distribution daily becomes stronger.

THE CONSTRUCTION OF THE ALEXANDER III. BRIDGE, PARIS.

By Jacques Boyer.

THE Alexander III. Bridge,* now in course of construction between the Champs Elysées and the Esplanade des Invalides, will be one of the most remarkable of the bridges over the Seine at Paris. Begun in 1895, the first project for the construction of the bridge underwent many important alterations, which now possess only retrospective interest; but, without going into the details of the engineering discussions on the subject, it will be well to indicate here the general conditions of the problem which its erection presented.

It was necessary that the bridge should suffice for the needs of both the navigation of the Seine and the circulation of the city, while at the same time satisfying certain æsthetic desiderata. As it is to be a part of the Exposition of 1900, it was needful that it should be decorative in character, at least to the extent that it would neither injure the appearance of the river nor obstruct the view of the Invalides from the Champs Elysées. Its width had to be sufficient to harmonise with its vast approaches on the two sides. In addition, this structure, situated below a bend of the river which throws the main current over toward the right bank, and only a short distance above the Pont des Invalides (see Fig. 2), is badly placed as regards the navigation of tows in the stream. It was, then, indispensable to construct the bridge without an intermediate pier, lighters and barges being difficult to steer in passing the arches of bridges with many piers. Furthermore, it was requisite that the fairway under the bridge should be wide enough to allow the straightening of tows of barges coming down the river and preparing to shoot the arches of the Pont des Invalides, this being necessitated by the deflection of the current toward the right bank, as mentioned above.

As these two conditions did not entirely harmonise with the artistic desiderata, the Gordian knot was cut by the adoption of the solution least hurtful to the interests of navigation. It was decided

* The present Emperor of Russia laid the first stone of the bridge on October 7, 1896, naming the bridge in remembrance of his father, Alexander III.

to build a bridge of a single, very flat arch, of which the level above the water should be as high as the laws of perspective permit. It was consequently designed so as to bring the roadway to such a height that an observer, situated in the prolongation of the axis of the bridge on the right bank, might just be able to see the base of the Hotel des Invalides over the rise of the bridge. The above various considerations were among those guiding MM. Résal and Alby, the engineers who furnished the plans definitely approved by the administration in January and July, 1897. It may be said here that the administration has sacrificed more to art than to navigation, reserving, for the time, the correction of certain practical inconveniences created by the situation.

Before going into the details of construction, it is well to have a general idea of the future bridge. It is of the three-hinged arch type (see Fig. 3), the total length of the bridge between the two abutments being 109 metres (357 feet). Its longitudinal axis coincides with that of the new avenue which will lead from the Champs Elysées to the Esplanade des Invalides, crossing the Seine almost at a right angle; or, more exactly, 83° 38′ (see Fig. 4). The parapets of the two banks of the river are 155 metres apart, the two approaches being each 22.5 metres long. No other bridge in France is constructed with such flat arches. The resistance and elasticity of steel have allowed it to be given a remarkable coefficient of rise, as the table below will show.

COMPARISON OF RISE OF SOME FRENCH BRIDGES.

(All dimensions in metres)

Name.		Opening.	Rise.	Ratio of rise to span.
Alexander III., (Paris)	single arch.....	107.5	6.28	$\frac{1}{17.12}$
Pont Mirabeau, (Paris)	central arch.....	99.34	6.19	$\frac{1}{16.05}$
Pont Morand (Lyon)	central arch.....	67.40	4.44	$\frac{1}{15.18}$
	side arch.....	64.00	3.96	$\frac{1}{15.90}$
Pont Boieldieu (Rouen)	side arch.....	48.80	3.70	$\frac{1}{13.00}$
	central arch.....	40.00	2.50	$\frac{1}{16.00}$
	side arch.....	54.60	4.87	$\frac{1}{11.00}$

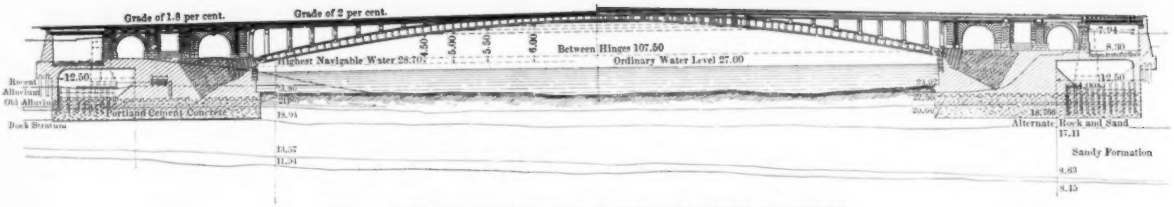


FIG. 3. LONGITUDINAL SECTION OF THE ALEXANDER III. BRIDGE.

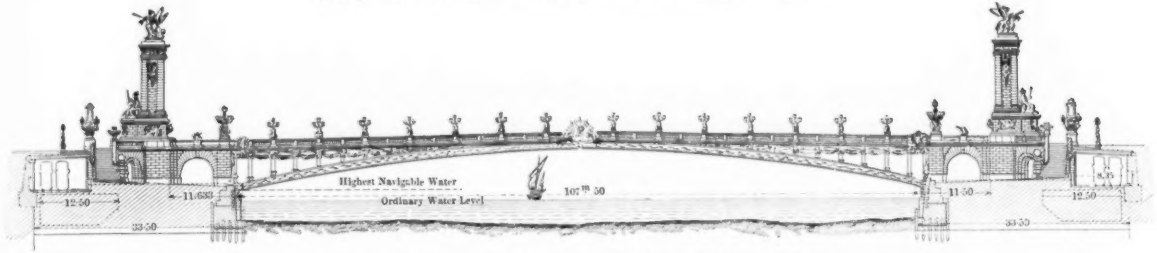


FIG. 1. GENERAL ELEVATION OF THE ALEXANDER III. BRIDGE.

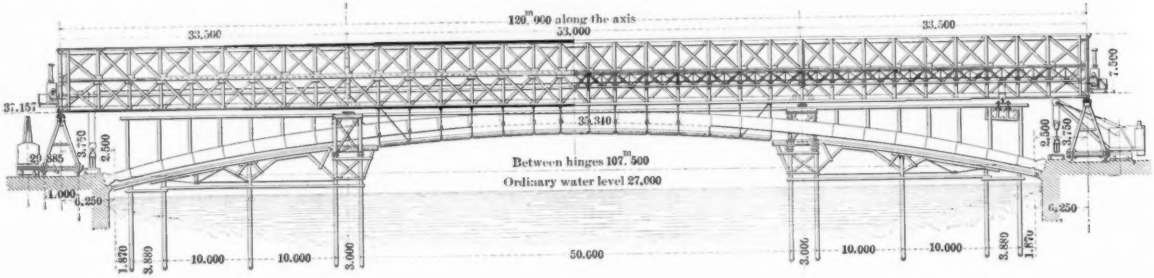


FIG. 13. SEMI-ELEVATION AND SECTION, SHOWING FALSE-WORKS.

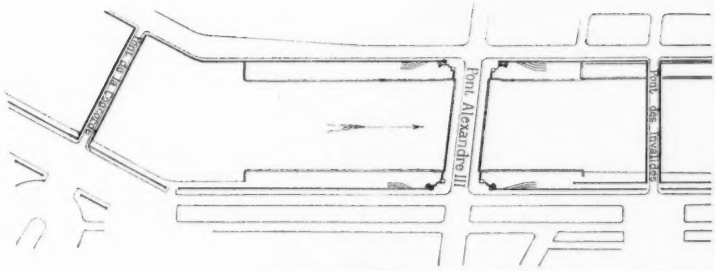


FIG. 2. GENERAL PLAN OF THE SURROUNDINGS OF THE ALEXANDER III. BRIDGE.

The flooring of the bridge rests, through the intermediary of vertical pieces, upon fifteen arches of cast steel, articulated in sockets at their springings. The triple articulation, assuring a proper transmission of pressures, renders the stability of the structure independent of temperature, and thus diminishes to a great extent moments of flexure in the nighborhood of the key. In this way the arches are subjected only to compression stresses.

On account of the flatness of the arches the abutments of the

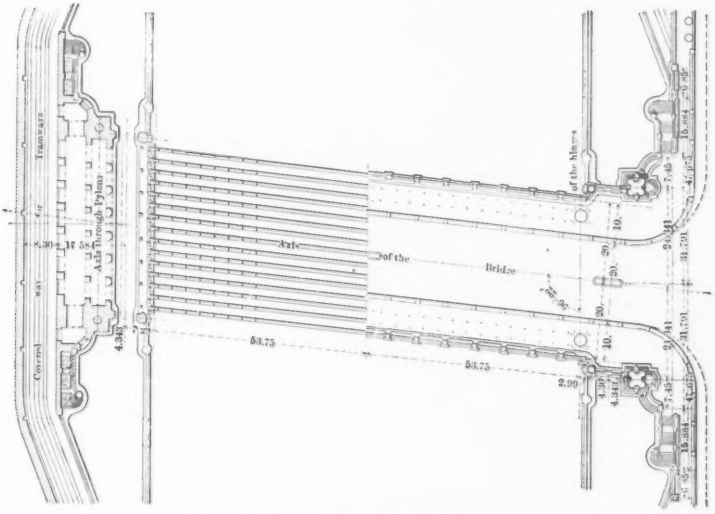


FIG. 4 PLAN OF THE ALEXANDER III. BRIDGE.
(On the right the superstructure is shown in place.)

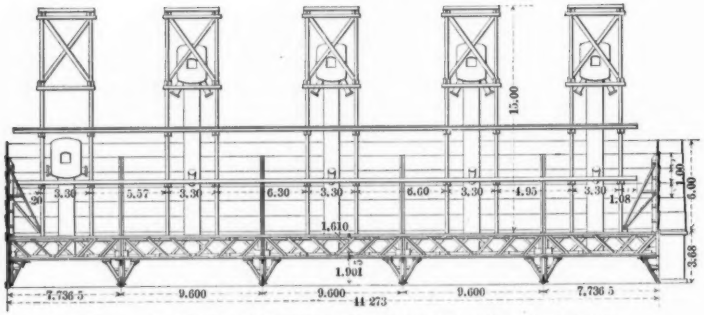


FIG. 5. LONGITUDINAL SECTION OF THE CAISSON AND SCAFFOLDING.

bridge will have to resist enormous stresses, to reduce which as much as possible, the metallic skeleton of the arches has been made as light as practicable and the dead weight of the flooring reduced by the use of high-quality material. As the springing articulations could not be placed lower than 2.25 metres above mean water-level, those at the key were carried to a height of 8.53 metres above the

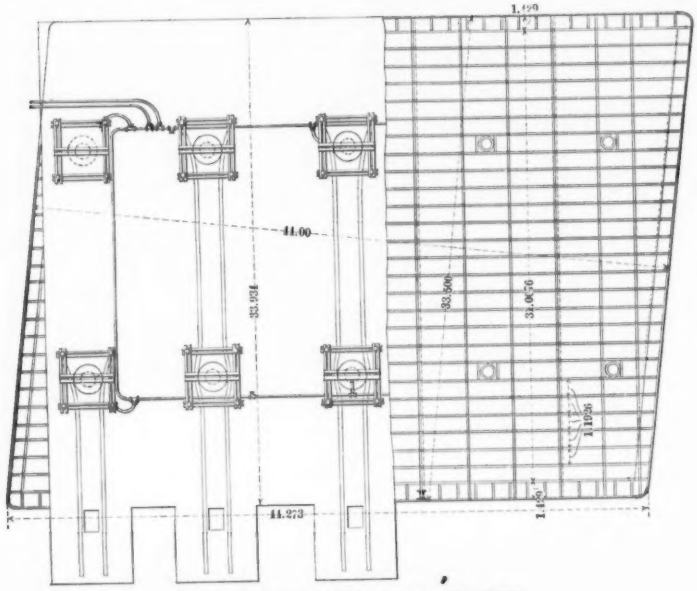


FIG. 6. PLAN OF CAISSON AND SCAFFOLDING.

same level, thus giving a very good headway under the bridge even at times of high water.

The Alexander III. Bridge will be the widest in the world, having a roadway of 20 metres width, on each side of which will be sidewalks 10 metres wide. The Austerlitz Bridge, in Paris, widened in 1884, is only 30 metres wide between its guard-rails, and the New York-Brooklyn Bridge only 25.5 metres wide. At each end of the new bridge the sidewalks are widened to give room for stairways leading to the quay level below. The terminal viaducts are pierced by several arches on each side of the Seine. The first allows of a passageway on the quay level, while two others connect with

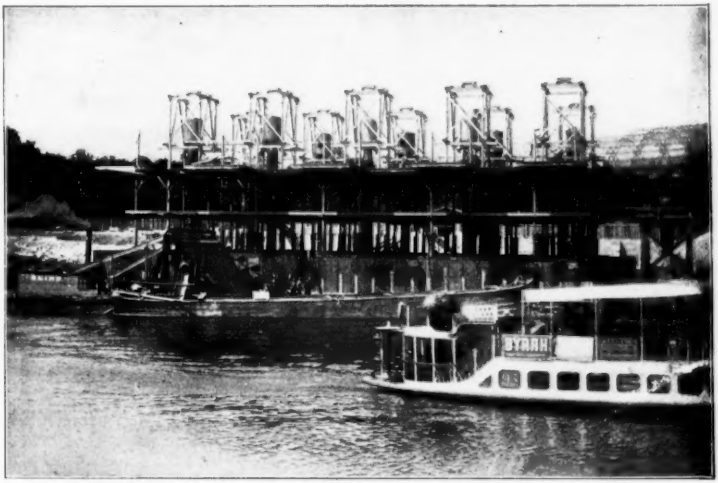


FIG. 7. THE CAISSON ON THE LEFT BANK DURING THE SINKING (SEPTEMBER, 1897).

the body of the masonry terminals on the banks. On account of the provisional shifting of the public highways of the city during the Exposition, covered ways are carried around behind the abutments.

After the adoption of the general plans, soundings were made for samples of the subsoil, in order to fix, from the data thus secured, upon proper conditions of stability for the abutments. It was decided to make the abutments so heavy that they would resist the thrust of the arch by their friction upon their foundations rather than by the backing of a retaining bank of earth. For this reason

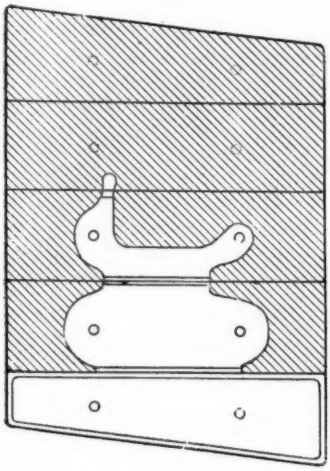


FIG. 8. METHOD OF FILLING CAISSONS.

The upper chamber is full, the second just filled; the others show the successive stages.

it was necessary to carry back the heel of the abutments, and to give them a footing of more than 20 metres. These works form, with the quay walls, a single piece of solid masonry, and, to bring their centres of gravity as near as possible to the curbing of the quays, they have been left hollow at their rear portions.

Each abutment is in the form of a parallelogram, of which the side along the axis of the bridge measures 33.5 metres. Their bases are masses of concrete 3.50 metres thick, composed of a mixture of three volumes of pebbles and two of mortar, the latter being made of 450 kilogrammes of Portland cement to one cubic metre

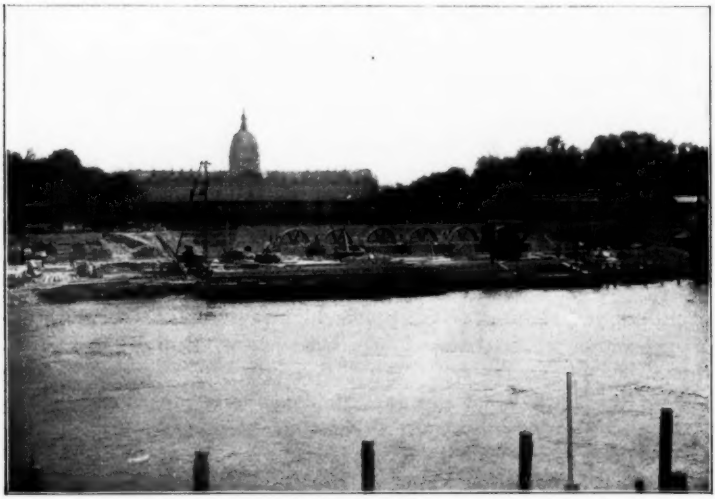


FIG. 9. THE PIER ON THE LEFT BANK DURING CONSTRUCTION (APRIL, 1898).

The dome of the Invalides is seen in the distance

of sand. To make a secure bond between this concrete and the masonry backing, the face in contact with the latter has been channelled with grooves. The upper part of the abutment is built of heavy stones laid in cement motar. Their faces, on the river side, are of ashlars below and of Vosges granite above. The latter portion is composed of three courses of 0.5 metres each and a moulded string-piece, above which is the foundation for the sockets of arch-hinges. Four granite courses are also placed behind each of the sockets, perpendicular to the direction of the thrust, the surface of each increasing in size as it approaches the central part of the structure. By this means the thrust is better distributed over the ordinary masonry, which can only support a crushing stress of about 18 kilogrammes per square centimetre, while the granite pillow-blocks under the sockets can resist 48 kilogrammes.

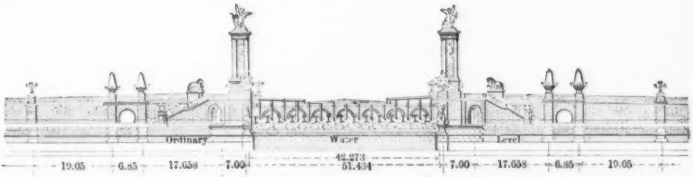


FIG. 10. TRANSVERSE SECTION OF THE ALEXANDER III. BRIDGE.

The contract for this work was let to MM. Letellier and Boutrinquieu, who used pneumatic caissons for the submarine work.

The length of the caissons, parallel to the course of the river, is 44 metres, and their width 33.5 metres, the surface of their bases being thus 1,484 square metres. The caisson proper is a sheet-steel cell 5 millimetres thick and 3.68 metres high. Its roof, which is designed to form a water-tight diving-bell when the edges of the partitions of the caisson are under water, is divided into two parts—a lower working-room 1.90 metres in height, and an upper level, forming a sort of tray in which is laid the masonry that is to carry down the caisson by its weight and afterward support the abutment. Since the metallic roof of the caisson could not alone support such a weight, the working-space was cut up into five sections by four partitions forming supporting girders, these being furnished at the bottom with knife-edges of mild steel. Angle-brackets around the sides of the structure help to sustain the walls of the caisson and the partitions are cross-braced to each other. On the upper surface of the roof of the caisson a series of 27 beams was laid at right angles to those just described.

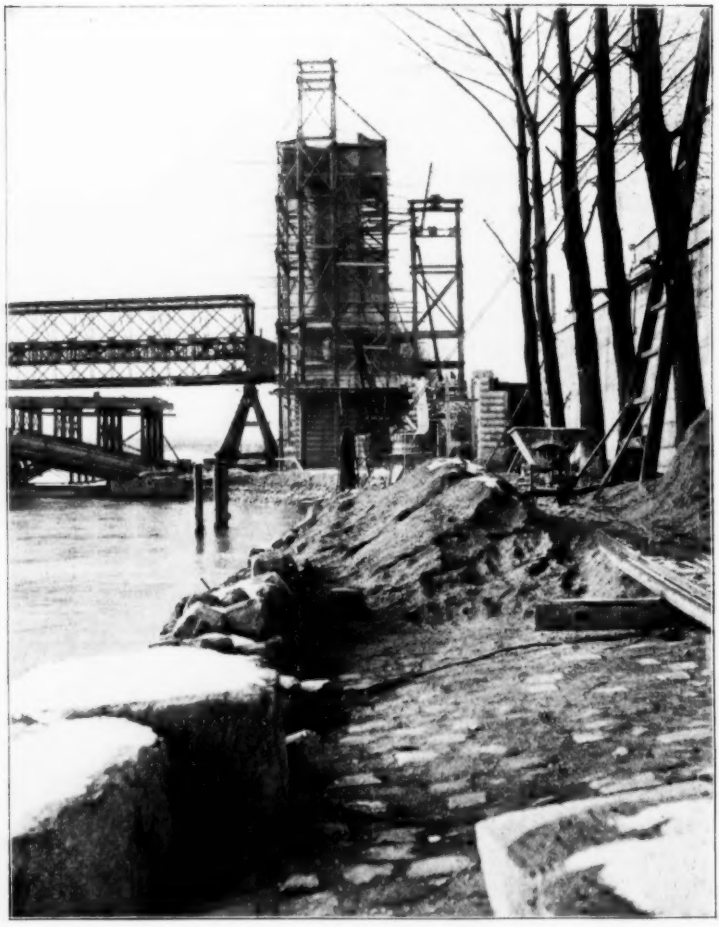


FIG. 11. STATE OF THE PYLON ON THE RIGHT BANK, FROM ABOVE. (FEB., 1899.)

Each of the five subdivisions of the lower part has two entrance-wells, provided with air-locks. In order to gain time the contractors constructed these wells of the total length that would be required at the time of beginning, instead of extending them as the caisson sank to its bearings. This arrangement made it necessary to build a scaffold 7.20 metres high about the work for the use of the Decauville

wagons, used to transport the excavated materials from the air-locks to scows moored in the river near by. A lower level of scaffolding, at the height of the upper part of the finished structure, is devoted to the masonry work. In this way the work of excavation and construction goes on continually, neither interfering with the other.

The caissons were rapidly sunk. The contractors received orders to commence work on April 19, 1897. On the left bank the first operations of construction commenced on May 28, and on August 11 concrete was laid on the roof of the caisson. During the sinking of the caisson great precautions were taken to insure regularity and to avoid any flexure of the metallic structure. The sinking was finished, without accident, on the right bank on November 7. In order to avoid interference the entire force in the caisson worked alternately at digging and at removing the excavated material. Among the other difficulties encountered were those due to the variable resistance of the soil and the increasing friction of the adjacent earth as the caisson sank more deeply.

When the caisson reached the proper depth, the surface beneath it, consisting of a sort of calcareous flagstone, was cleaned and levelled and treated to a coat of neat cement mortar, upon which the concrete

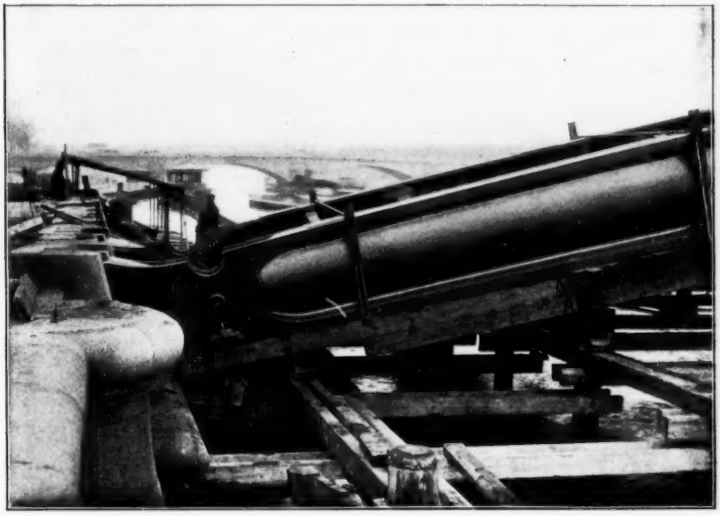


FIG. 12. A TERMINAL VOUSSOIR, SHOWING HINGE AND BEARING ON THE PIER.

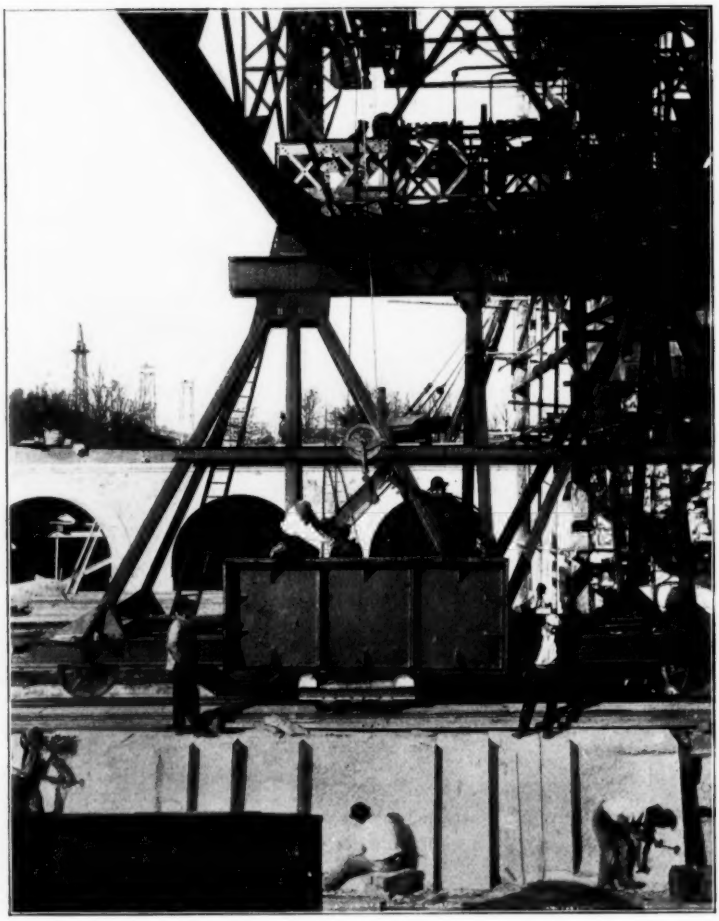


FIG. 14. ONE OF THE SUPPORTS OF THE FALSE-WORK TRUSS.
In the foreground an arch-voussoir is being handled, and the masons are dressing the granite face of the pier.

was filled in. The successive chambers of the caisson were filled in the manner shown schematically in Fig. 8, the men retreating from one to another as the work progressed. This ingenious arrangement allowed the electric lighting of the workings to be maintained to the end. To finish the work, by filling the air-lock wells, it was, of course,

necessary that the part below should be thoroughly water-tight. This was successfully accomplished by running in a stream of thin, neat, cement mortar. When this was set, a circular wooden plug, tightened in place by wedges, was inserted, and a further run of the cement mortar flowed in until the air-lock shafts were full to a point 0.60 metres below the bolts holding the upper part to the roof of the caisson. When the last shaft was filled the perfect tightness of the work was noted by the rapid fall in the consumption of compressed air. To make sure, however, that there should be no infiltration of water and washing out of concrete the pressure was kept on for 48 hours after the last mortar had been flowed in.

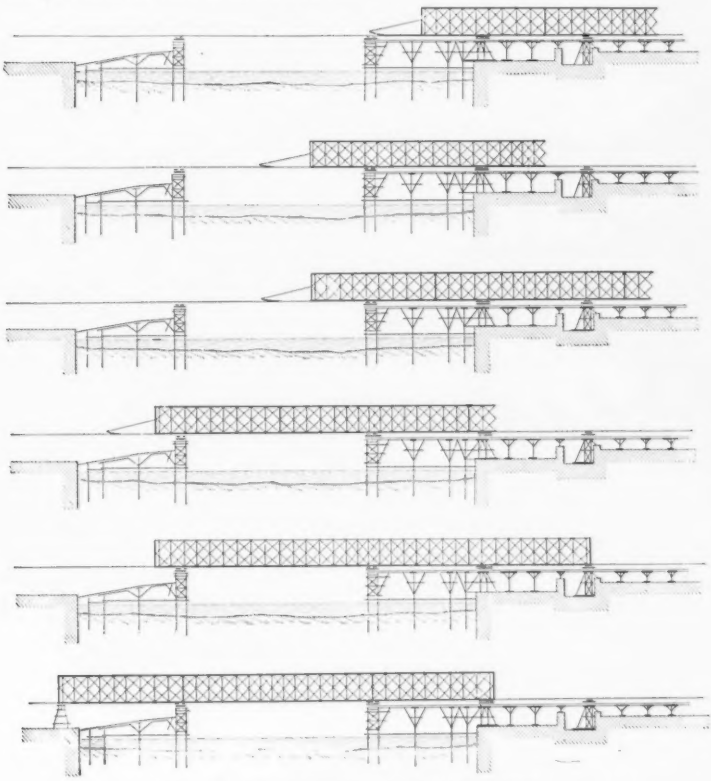


FIG. 15. THE ERECTION OF THE FALSE-WORKS.

Showing the manner in which the truss was constructed and launched, without interrupting navigation.

Compressed air was furnished to the workings by the Compagnie Parisienne Victor Popp, through a special pipe laid from the main passing over the Pont de la Concorde. After passing through a meter, one of which was installed at each working, the air was reduced to the pressure necessary for the caissons. The distribution-pipe was led around the upper-level scaffold, branches containing cocks leading to each of the chambers below. Electric lighting was supplied from an isolated plant, consisting of two vertical Raworth engines of 25 horse-power, direct-coupled to continuous-current dynamos. The mean daily consumption of current was 200 kilowatt hours, of which

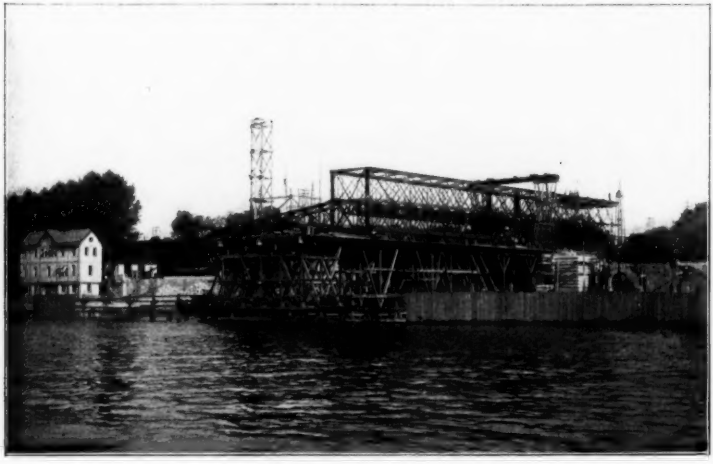


FIG. 16. THE FALSE-WORK TRUSS BEFORE LAUNCHING. (AUGUST, 1898.)
The engineer's office is seen on the left.

150 were consumed in the caissons by the 160 lamps they contained. Forty 50-c. p. lamps, grouped in sets of four, were used for exterior lighting.

On November 9, 1897, the scaffolds and upper parts of the air-lock wells were removed. On the right bank the work under compressed air lasted 79 days, on the left bank only 71 days, and this with an interruption of three days caused by fear of a freshet.

Passing now to the superstructures of the abutments, there is nothing especially noteworthy about the work of construction now under way upon them. Certain parts of this work can not be finished until all the metallic parts of the bridge are completed and the false-

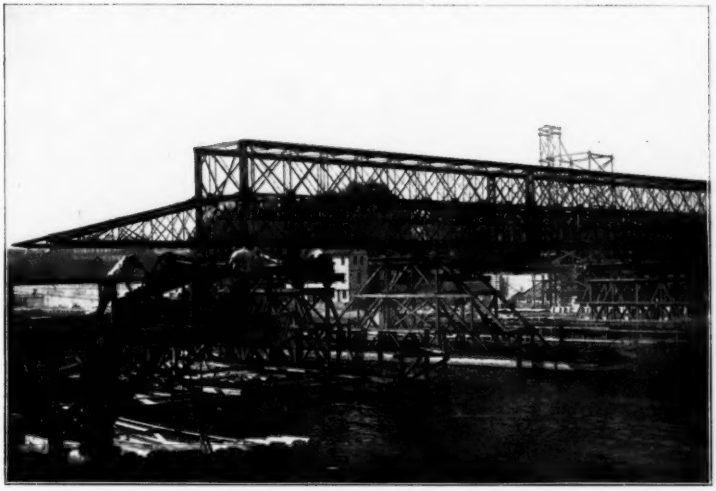


FIG. 17. THE FALSE-WORK TRUSS AT THE SECOND STAGE OF THE LAUNCHING. SEPTEMBER 8, 1898.

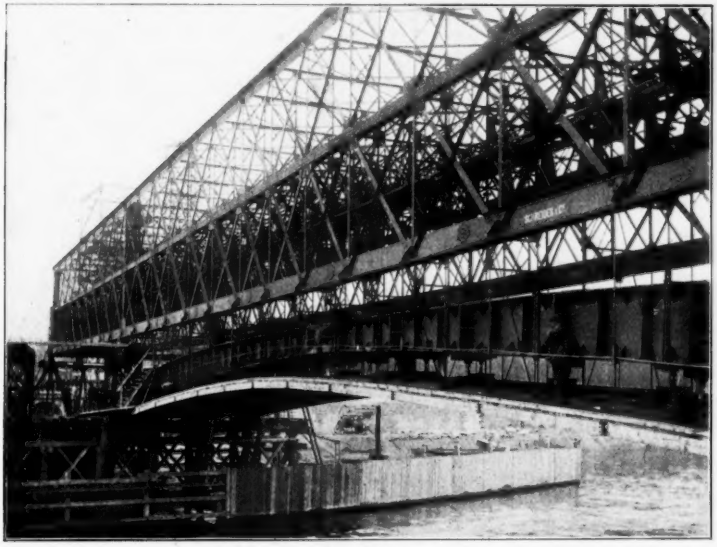


FIG. 18. ERECTION OF THE FIRST TWO ARCHES, CLOSE OF 1898.

FIG. 19. A GENERAL VIEW OF THE ALEXANDER III. BRIDGE. PHOTOGRAPHED FROM BELOW ON THE LEFT BANK, FEBRUARY, 1899.

Pont de la Concorde in the distance, Palace of Fine Arts of the Exposition on the left.

work removed. The following description of the superstructure was furnished by MM. Résal and Alby, to whom the writer wishes to express his thanks.

The arrangement of the arches above the platform is the same on both sides of the river. (See Figs. 3, 4, and 10.) Above the quay the platform of the bridge is formed of four spans of structural steel beams, resting at one end on cast-iron columns, which stand upon the granite blocks from which the arches of the main bridge spring, at the other upon the quay wall, and upon three intermediate walls parallel to the Seine. In these are left seven semicircular openings, shown at the left side of Fig. 19. The passage under the span nearest the river serves for the tow-path, while that nearest the quay wall will permit the passage of two lines of tramways. At the ends of the second span are two flights of steps, by which the public will have access to the quay and to the space under the other two spans. The pylons, placed at the extremity of each balustrade, occupy the width of the third span. At the time of writing, those upon the right bank are very well advanced. The up-stream pylon has reached (see Fig. 11) the height at which the statue and the four columns sustaining sculptures will rest. The pylons on the other end of the bridge are not yet so far advanced.

The metallic part of the bridge is composed of two parts, which will be considered in order—the cast-steel arches and the sheet-steel platform which they support.

On account of the costly nature of cast steel the engineers were obliged, in their design of the arches, to observe the greatest economy of material. To cast steel properly is much more difficult than to cast iron, on account of peculiar conditions encountered in cooling it. That the risk in moulding might be minimised the pieces were made as simple as possible and as much alike as the design permitted, for in this way experience acquired in the successful casting of one would render the manufacture of others more certain and safe.

Normally, the neutral line of a three-hinged arch should approach in general form the curve of pressure, and consequently the material should be distributed around this line with a gradual entasis. Furthermore, in order that the intrados should have the greatest possible rise, without making the roadway too high, the thickness at the key must be kept at a minimum. These conditions were satisfactorily accomplished, with due regard to æsthetic considerations, by diminishing the depth of the arch-members proper from 1.50 metres at the entasis to 1 metre at the springing, and .90 metre at the key. These

data, calculations into the detail of which it is unnecessary to enter, gave definite form to the arches, while at the same time certain exigencies of manufacture have been observed in the dimensions and weight of the voussoirs. The number of the arches was fixed at fifteen, and their distance apart at 2.875 metres, centre to centre. The length of the voussoirs was limited on account of shrinkage in casting. To determine them the chord of each half-arc was divided into sixteen parts—fourteen of equal length, 3.625 metres, and two shorter parts (at the ends)—the corresponding lengths of the voussoirs being from 3.615 to 3.725 metres. Each is cast with flat rectangular ends, which are carefully machined to fit over their whole widths, fitting-strips being left to compensate for any irregularity. Then connections between them are made with twelve bolts.

On account of warping and shrinkage, it was impossible to make any two voussoirs absolutely identical, and it was impracticable to tie neighboring arches together with any system of cross-bracing. The system of support was reduced to simple struts standing on the extrados, but at the middle of the bridge, where the small thickness of structure allowable required the suppression of all intermediate pieces, the superstructure was bolted directly to flanges cast on the upper surface of the voussoirs.

The voussoirs which form the hinges at the end of each half-arch are of quite a different shape from that of the intermediate voussoirs, the ends forming bearings for cylindrical knuckle-pins, while the upper and lower flanges of the arch come together into one mass of metal. At the springing-hinges the thickness of metal of the bearing is 15 centimetres, while at the key it is 12 centimetres, the length of bearing in each case being 80 centimetres.

The pillow-blocks at the springings are of a design harmonising with that of the terminal voussoir, which they resemble in general arrangement. It being impossible that the parts of the arches should be rigorously of the desired size, a shim of a few millimetres thickness is put between each key-voussoir and its neighbor as a means of adjustment.

The method of assembling the arches is of great interest. This operation is one of much delicacy, for the least mistake may compromise the final success of the undertaking. In this case it was more delicate than usual, because the contractor was required by the specifications under which he worked to carry the centerings of the arch upon a movable bridge, capable of being placed in successive positions for the various arches, without interfering with navigation in

the stream below. This gigantic travelling-crane is supported by tracks upon which it rolls in making its transverse movements, these tracks being placed on the abutments. As the absolute necessities of navigation require a passage of only about 50 metres, the ends of the arches, near the springings, were mounted on centerings supported on piles on each side of the central passage. In this way the moving bridge was relieved of a large part of the load of the arches when they were being erected, and while this method of doing the work required most expensive auxiliary apparatus, at the same time it permitted the simultaneous assembling of two arches.

The size of the moving-bridge makes it the most important piece of erection apparatus ever built in France. The distance between the shore supports is about 120 metres (394 feet). In the construction of this large single span the weights, stresses in moving, and wind-stresses had all to be considered. It is composed of two trusses 5.71 metres apart and 7.50 metres high. These are cross-connected by panels consisting of two vertical struts and a horizontal cross-piece between their middles. Brackets on these and on the struts carry two tracks, on which run the trucks used in handling the voussoirs. Above the central horizontal cross-pieces the structure is stiffened by tension members, while below it is left open for the easy manipulation of the voussoirs of the main arches.

The supports of the moving-bridge upon the banks (Fig. 14) are of pyramidal shape, their upper surface consisting of a triple-panel framework, parallel to the direction of the river. Their height is 5.45 metres, the distance between the end rollers of each set 11.50 metres, and the gauge of the rolling-tracks 4 metres. Upon the false-work in the river the bridge is supported on metal columns resting on rows of piles. The length is divided into three spans, 53 metres for the middle one and 33.50 metres for each of the others, by the support of the false-work referred to.

The structure was assembled on the right bank of the river, its parts having been made and mounted temporarily in the shops of the Maison Schneider, at Cruesot, under the supervision of M. Rochebois. The first pieces of the material were delivered in the middle of July, 1898, and by the use of a wooden scaffolding of the proper height were assembled and put in place in several sections. Figure 15 shows, schematically, the successive steps in these operations. To reduce the stresses on the framing during the overhanging period of the second operation, the end of the moving-bridge was furnished with a light nose, 15 metres long. The three launchings (Figs. 15, 16, and

17) took place on August 20 and September 8 and 30, 1898. None required more than half a day's time, and the movement of boats between the Pont de la Concorde and the Pont des Invalides was only stopped during the second maneuver, and then only for two hours. Power for moving the structure was applied through two windlasses acting with two pullies. The roller-carriages had from two to four rollers each, according to the load upon them. Only eighteen men were required to move this enormous mass, which, with its supporting apparatus, weighed 238.5 tons. Both wood and metal parts held up well under the stress, and at the moment of greatest overhang the sag observed was only 16 millimetres over the support on the shore-piling, while the nose engaged with the apparatus for its reception without necessitating the use of jacks to assist it.

The platform on which the men work at assembling the arches is hung from the moving-bridge by a series of rods, furnished with screws for adjusting the height of the platform, and is so arranged that for a single position of the moving-bridge two arches can be erected. The voussoirs are delivered at the foot of the work, where they are picked up by crane-hooks and deposited very nearly in their final position on the centering, the operation being conducted simultaneously from both ends. Each voussoir is brought approximately to its place by the use, under it, of two oak wedges. Then, to obtain the precise curve desired in the support, plates of metal are laid on the scantlings of the centering, and upon these thin steel shims are laid, the voussoirs being lifted for this purpose with ordinary pinch-bars. The members are united by means of bolts placed in the interior of each of them.

When the assemblage of the first two arches was completed (November, 1898), the moving-bridge was rolled into position for the construction of the next two. This operation was very simply conducted by hand-power, the men using capstans to roll the roller-carriages supporting the moving-bridge.

At the end of February, 1899, at the time of the visits made in the interests of this article, four of the arches were in place. Figure 19 shows the state of the work on the bridge at that time, and allows the elegant form of the arches to be clearly seen.

In conclusion, it is of interest to note the cost of this work. The foundations of the two abutments cost nearly 1,600,000 francs. The metal-work and masonry, of which the architectural part was designed by MM. Cassier-Bernard and Cousin, are estimated at about 4,500,000 francs, making the total cost about 6,000,000 francs.

HYDRAULIC TRANSMISSION AND DISTRIBUTION OF POWER.

By E. B. Ellington.

THERE is some danger that the growing popularity of the dynamo may lead to undue depreciation of the value of older systems of power-distribution. From the point of view of universality of application, electricity possesses advantages to which no other method can lay claim, but there is to be noticed a tendency to assume that, as it can be used for nearly all purposes, it is therefore in all cases the best system to adopt.

In time the true economic limits of the application of electricity will no doubt be better understood, and it will be found that the older systems cannot be displaced for many purposes without the sacrifice of economy in production of the power required and of efficiency in its use.

Water was probably the first substance used for power; the waterfall has from the earliest times been utilized for this purpose.

Notwithstanding the advent of steam as a practical source of power in the last century, and the enormous development that has taken place in its use, water-power under favorable conditions continues to be the best and cheapest obtainable, and, with the exception of wind, it is the only one in nature ready-made. If it were suggested as a practicable method of raising water to evaporate it first and condense it at a higher level afterward, I am afraid the sanity of the engineer responsible for the suggestion would be questioned, and yet on the great scale of nature this crude though direct method has given us a perennial supply of power greater beyond measure than that contained in all the coal in the world.

Electricity is on a different footing altogether. There is, so far as we know, at present no perennial natural source of electricity which can be drawn upon. One of the most valuable results of the advent of electricity as a means of power-distribution is the impetus it has given, and will continue to give, to the utilization of the great natural falls of water the world over. It is a fact recognized by everybody, that water is a very suitable and an extremely valuable substance for power-purposes. It is, I think, also a generally accepted fact that dynamos can be run by water-power, and that by

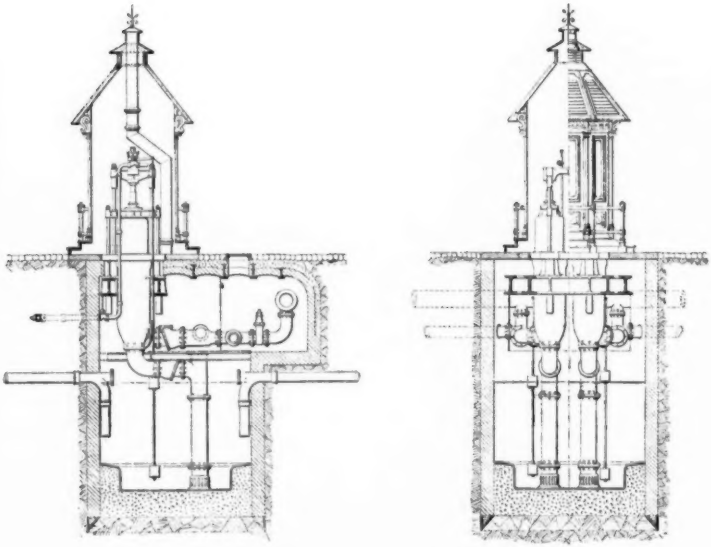


FIG. 1 ARRANGEMENT OF SUMPS AND SEWAGE PUMPS.

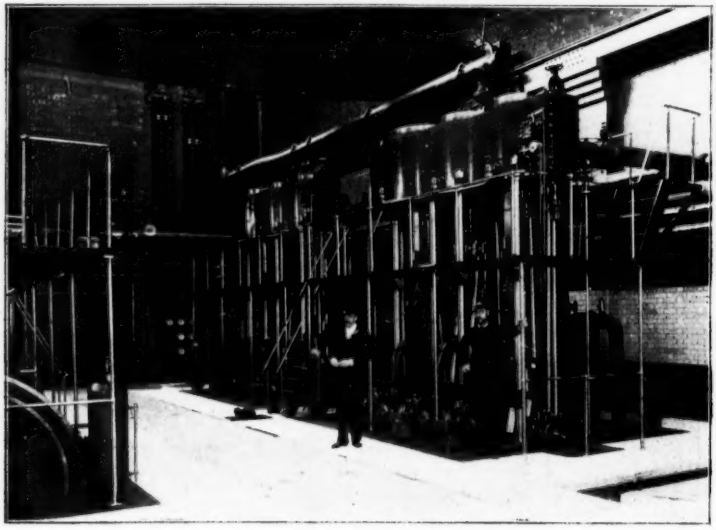
such means electrical energy may be obtained more cheaply than by any other method. If this is admitted, then it must be profitable to transmit water some distance to the dynamos, in place of using any other power for production of electricity. There would still remain the question, under what circumstances is it better to convey the water to the dynamo, or the dynamo to the water; and on this point there is a great deal to be said. The loss of power in transmission is in both instances independent of the pressure, and theoretically this loss can be made in both cases as small as is desired.

The loss in case of hydraulic supply through mains is inversely as the fifth power of the diameter, while in electrical transmission it is inversely only as the square; but the practical limit of hydraulic pressure is soon reached, while the electric tension can be almost indefinitely increased. It is due to this fact that for long-distance transmission electricity is the only power that can be economically employed. As high-tension currents are unsuitable for most industrial purposes, a second conversion to low tension is required, and as there is a considerable loss in the process, it seems clear that there must be economy in conveying hydraulic power to the dynamo a

certain distance. This interesting question has not received in England the full consideration it deserves, but Continental engineers have investigated the question. One of the first, I believe, to do so was the late Professor Von Rysselberghe, of Ghent, who, in a somewhat characteristic fashion, seemed to think the difference between the fifth power and the square settled the question. He succeeded so far in pressing his views on the municipality of Antwerp that, notwithstanding the hydraulic pressure had to be created artificially at a central station, hydraulic instead of electric transmission was adopted for the electric lighting of the city. The conversion into electric current is effected by turbines and dynamos at several substations as it would be from natural falls of water. The turbines and dynamos are not of the most efficient sort, and the general efficiency of the system is low, but the cost of fuel per unit generated compares not unfavorably with many electric installations. MM. Bergès and Bravet, in a communication to the Société des Ingenieurs Civils de France, in May, 1897, on the project for the electric lighting of Lyons by means of water-power from the Rhone, showed that it would be more economical to carry power hydraulically from the falls to Lyons and effect the conversion there than to use high-tension currents with transformers.

FIG. 2. DOUBLE HYDRANT, WITH HOSE ATTACHED.

The system advocated by these authors involves the conversion of the waterfall into a high-pressure supply, and the subsequent conversion of this high-pressure water into low-tension current. In the ordinary system there would be the initial conversion of water-power to high-tension electric power and the subsequent conversion of high into low tension. It was, no doubt, a wrong conclusion for M. Bergès to arrive at, though theoretically his calculations were correct. The main factor governing these questions of long-distance transmission of power is not, however, theoretical efficiency,



ENGINES OF LONDON HYDRAULIC-POWER COMPANY, WAPPING STATION.

but capital outlay and cost of maintenance; and the position of the turbines and dynamos in relation to the source of the water-power to be utilized must depend on local conditions.

The combination of water-power and electric transmission is apparently destined to become the predominant means of power-distribution. At the present time, however, notwithstanding all that has been done in this direction, the distribution of power as a whole is dependent principally not on any natural supply, but upon fuel. The term "hydraulic power" is generally applied to water-power plants where steam pumps and accumulators are used to create and

maintain a high water-pressure (usually about 700 pounds per square inch) in closed mains. There are cases, especially in California, in connection with hydraulic mining, where a pressure of 600 pounds per square inch and upward is obtained from a natural fall, but with these exceptions, wherever there is a distribution of hydraulic power the initial apparatus is a steam-pump or its equivalent. Of course any waterfall can be made to drive a pump as easily as a dynamo, and the conversion of any low-pressure supply into high-pressure can be effected by means of a differential pump with a loss of about 10 to 20 per cent. in the process. It is rarely advantageous to do so, owing to the cumbrous nature of the apparatus required. The most common case occurs when the flow of the stream is made to actuate a "hydraulic ram" to send a portion of the water to a higher level. There the apparatus is very simple, but the efficiency is low. Low efficiency in such case is seldom of any consequence. The converse case, in which a small quantity of high-pressure or hydraulic-power water is used to raise a large quantity at a less pressure, is frequently resorted to, as in mining and in sewage hydraulic pumps (Fig. 1), and also in injector fire-hydrants (Fig. 2). The efficiency of the former may be as high as 80 to 85 per cent., but is a good deal less if the low-pressure is only a few feet head. The efficiency of the fire-hydrant also varies considerably under different conditions, but is never more than 33 per cent. Like the "hydraulic ram," which may in a certain sense be considered its converse, it is a most useful apparatus, owing to its great simplicity, and it is also interesting as being the nearest hydraulic analogue to an electric transformer. The singular close analogy between hydraulic and electric mechanical phenomena has been frequently pointed out, and here we have a case of hydraulic induction. This, however, by the way. Usually where hydraulic power is required it is necessary to start with a steam-pump. Now, the pumping of water at a comparatively high pressure has long been recognized as giving the best duty of any work that a steam-engine can be set to do. In the celebrated trial of the "Milwaukee" pumping-engine, by Professor Thurston,* the combined mechanical efficiency of the engine and pumps was about 90 per cent.

The efficiency of a steam-engine driving a dynamo may, under the most favorable conditions, press the pumping of water very close, but certainly does not excel it. As in practically all cases of power-supply the engines can not be kept continually running at

* Transactions Am. Soc. Mech. Eng., Vol. XV.

their maximum output, the advantage in practice of pumping water over working a dynamo is very considerable, because at light loads the pumping-engine is much the most economical, owing perhaps mainly to the fact that it is the speed only which is varied with the demand.

By far the largest hydraulic-power supply is in London. There are now 106 miles of mains laid in the public streets, constantly charged to 750 pounds per square inch. The cost for coal (sea-borne, rough, small) per 1,000 gallons sold during the past four years has been as follows:

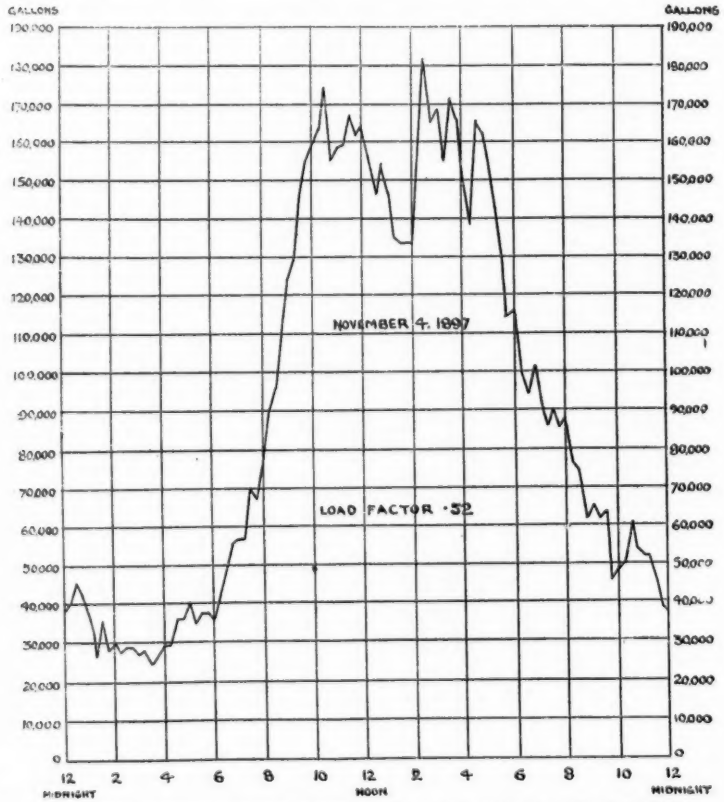


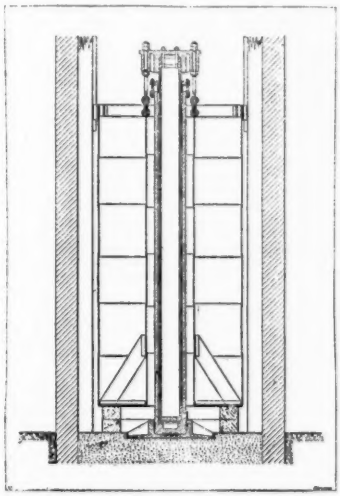
DIAGRAM SHOWING AMOUNTS OF POWER SUPPLIED AT DIFFERENT HOURS OF THE DAY

MAXIMUM DAY'S PUMPING, LONDON HYDRAULIC POWER COMPANY.

	1894.	1895.	1896.	1897.
Coal-cost per 1,000 gallons sold ..	2.36d.	2.47d.	2.18d.	2.15d.
	1894.	1895.	1896.	1897.
Thousands of gallons sold....	332,390	375,678	412,398	523,732

Everyone acquainted with the subject will admit that this is a very satisfactory statement, but it is by no means the best that the hydraulic-power system can accomplish.

If it were possible to maintain the efficiency of trial-runs of the plant on continuous running at full speed, the cost of fuel would be 40 per cent. less, and if the whole output could be produced at one station instead of at four, at the trial-economy of the best station the cost would be reduced 50 per cent.



WEIGHT-CASE ACCUMULATOR.
Ram, 20 inches diameter; stroke, 23 feet 700 lbs. working pressure.

The significance of these figures can be made more apparent to those who are accustomed to electrical standards by converting the cost per 1,000 gallons into the corresponding cost per unit.

If the cost per 1,000 gallons is divided by 6.518, it will give the corresponding cost per B T. unit (kilowatt hour), thus: Cost of coal, London Hydraulic Supply, at per B.T. unit, 1894, .362d.; 1895, .378d; 1896, .334d.; 1897, .330d.

There are four London pumping-stations, situated about three miles apart, provided with engines in all of 4,600 horse-power. Of these stations three are on the river Thames, and one is on the Regent's Canal, City Road Basin. A fifth station, of about 1,500 horse-power, is to be erected adjoining the Surrey docks, Rutherhithe. In all cases coal is delivered by barges alongside the stations. At only one of the stations is the pumping-pressure 750 pounds per square inch. At the others the average pressure is quite 800 pounds per square inch, but, as the difference is necessary in order to obtain 750 pounds throughout, it is, I think, right to make the calculations on the lower pressure. The figures in the same districts of the public

electric supplies in London are very different. The lowest cost in any district in London in 1897 for electricity supply was .51 per unit sold, and the average cost in the principal districts covered by the hydraulic supply was very considerably more.

It may be said that this is not a fair comparison, and that it is necessary to take into account the difference in the load factors between power-supply and lighting-supply. The load factor of the hydraulic supply in London is certainly a high one, the average of the years 1894-97 inclusive being .34, but, as I have frequently remarked, the influence of the load factor alone on the coal consumption of a hydraulic supply is not sufficient to affect the broad conclusion. If the load factor of the hydraulic supply were reduced to two-thirds of its existing value, or about the same as many electric supplies, the coal cost per unit would only be increased about 10 per cent. The load factor has a greater influence in the case of electric distribution, but this is most distinctly a point in favor of the relative economy of hydraulic power. Then there is the question as to how the high load factor of the hydraulic supply in London is obtained. It is often assumed that a load factor of .33, or an average of work of 8 hours in the 24 at the maximum rate, can be depended on in power-supplies, and certainly the experience in London seems to corroborate this view. I have had experience of hydraulic-power supply in many other towns, and in no case except London has the load factor reached so high a figure. London is very peculiarly situated. The same thing occurs with the demand for power, and to a considerable extent for light also. During the day, and up say to between 5 and 6 o'clock in the evening, the principal demand is in the city. It is precisely at this time when the West End demand increases, reaching its maximum about 8 o'clock. Again, there are in a portion of the city and at the East End, the docks, the riverside wharves, and the railway goods yards, where there is frequently a very heavy demand at night. Though the load factor of all these various supplies considered separately varies approximately from .12 to .25, yet their combination produces the high load factors which the hydraulic-power supply in London yields.

No advantage would be gained from this fact if were not that the whole of the districts from Kensington in the west to Limehouse in the east are served from the same stations. Notwithstanding, the highest load factor obtained in any period of twenty-four hours is usually about .50, or twelve hours out of the twenty-four, which is less than is obtained at times by lighting alone in some of the West

End districts. From an examination of the records of the coal consumption of the electrical supplies in London, where the stations are at a considerable distance from the demand, and where high-tension currents and transformers have to be used, it seems to be a sound assumption that it would be impossible to substitute an electric system at the four stations of the Hydraulic Power Undertaking in London and distribute the power over the area covered by the hydraulic mains at the corresponding current and at a suitable voltage for the general industrial purposes of the districts, without a very large increase in the coal-bill over that required for the existing hydraulic supply. The facts given are, I think, sufficient to show that hydraulic power supplied over areas considerable in themselves, yet limited to five or six miles from the source, stands in a quite unrivalled position as regards economy in consumption of fuel.

It is unnecessary to consider in detail other items of the central-station cost. As Professor Kennedy has pointed out, they are substantially functions of the coal-bill.

The accumulators bear an important part in the economy of hydraulic-power supply, but in a large and comprehensive plant, such as that in London, they are not of the same kind of value as in most private installations. Where a bridge has to be opened at intervals accumulators are real reservoirs of power, but in a general supply they are merely regulators of pressure. In London their combined storage capacity only represents about one-half minute's pumping of the whole plant, and at busy times of the day they are usually stationary. Nevertheless they are of great importance in facilitating the control of the plant, so that the constant watching necessary in a large electric central station is not required.

MINERAL RESOURCES OF THE ANTILLES, HAWAII, AND THE PHILIPPINES.

By David T. Day.

THERE are two interesting view-points for studying mineral resources. One is the old idea of hidden treasures, which actuated Columbus in searching for a new world. In a modern view this embraces all minerals which could be exported with profit, if found in any considerable quantity and in reasonable purity. The other concerns all mineral resources which are essential to the development of any comparatively isolated locality; that is, surrounded with even a few hundred miles of ocean, and thus cut off from the economic use of the lower-grade minerals of other lands.

From both view-points the Hawaiian Islands are essentially poor; the Antilles are thoroughly well provided with mineral necessities and advantages; both Cuba and Porto Rico are to some extent supplied with buried treasures; and the Philippines, in the great variety of conditions prevailing in the different islands, can be said to be well supplied with mineral treasures and necessities.

We are already well acquainted with such mineral resources of Cuba as have been or are likely to become valuable exports to the United States. Were it not for the fact that the United States is already better equipped with mineral deposits than any other country in the world, the chances for finding useful application for the minerals of this island would be more favorable. Nevertheless, the cheap water-transportation between Cuba and such ports as Baltimore, Philadelphia, and New York have made us in the past take advantage of the large and cheaply worked deposits of iron ore in the neighborhood of Santiago; and as these deposits are owned in the United States, the use of them will largely increase at Sparrow's Point, Baltimore, and other eastern steel-works. In fact, the condition of the iron-ore trade between Cuba and the United States is epitomized by the picturesque statement, in the New York *Tribune*, that probably some of the shells fired from the fleet at Santiago found their resting place in the very deposits of iron ore from which they were made, because the ore from these deposits has been converted into steel at the Bethlehem Iron Works and at other places, to furnish suitable material for Carpenter and other projectiles.

We will look to Cuba for manganese with much more interest than for iron ore. Even if the exports are not so large, they are more important, because of the real deficiency of supply at present in the United States These deposits, also in the neighborhood of Santiago, will be developed beyond anything that we could do under the Spanish régime, although the American miner has always been in the habit of mining ores wherever they have been found and under any government, adapting himself most practically to the particular conditions there existing, and in successful competition with the natives.

A great deal of attention will be given to the subject of reopening the old copper mines worked for many years, but closed in 1873, and now flooded with water, and the utilization of them again will be simply a matter of competition with what exists in the United States.

Cuban asphaltum has established itself in the United States market, and the exports will probably continue until they finally succumb to the equal popularity of the various deposits of asphaltum now being developed in the United States. There are so many varieties of asphaltum that almost every use can be supplied from United States deposits. It will be remembered that the conditions of occurence of asphaltum in Cuba are sufficiently unfavorable almost to offset its ready adaptability for such purposes as japanning and other uses requiring special properties in the crude material, it being thus far found principally under water. Much of it has been used in Cuba for making gas to supply the lack of coal, none of which is found on the island.

Far more interesting than its asphaltum deposits is the suggestion of future value to come from petroleum on this island. So far the production of petroleum has been entirely experimental, but the quality of the oil produced has been most interesting. It is naturally a light-colored oil of agreeable odor, and consists almost entirely of hydro-carbons boiling almost uniformly above 250° and under 300° C. No paraffine is obtained from the oil. The absence of sulphur compounds, which was inferred from the absence of disagreeable odor, was confirmed by boiling with metallic sodium, whereby not the slightest trace of sulphuric reaction could be obtained.

It is reported by Dr. H. N. Stokes that—

"At Santa Clara, Cuba, there is a spring known as Sandalwood Spring, from which issues with the water a certain amount of petroleum, which, from its peculiar odor, is called 'sandalina,' or sandalwood oil, although it more closely resembles the odor of cedar. The oil is collected from the surface of the water, and used as illuminating oil and for other purposes without being refined."

Dr. Stokes found that the oil, which is about as viscous as strong sulphuric acid, is perfectly transparent, amber-colored, and shows the merest trace of bluish-green fluorescence. Its odor, as above mentioned, is agreeable and in no way suggestive of even refined American petroleum, but rather of cedar-wood.

Further search in this direction will undoubtedly be carried forward vigorously, with the object of adding to the already considerable American supplies of petroleum, another producing locality easily accessible, and whose product will be readily transported by tank-steamers to the refineries of the United States, or be directly exported to European countries.

While we are well acquainted with the export minerals from Cuba, we are now interested in the mineral resources of this island from an entirely different point of view—that which may be necessary to promote the successful industrial development of the island itself. The serious lack of mineral fuel on the island can be largely replaced for a long time by the abundance of wood. The sandstone formations of the western end of the island have furnished soils well adapted to the development of large forests of pine trees, while the central portion of the island is also well wooded, and a large rainfall results as the forests are cut down. While the lack of mineral fuel will cause such structural materials as are made of steel to be brought from the United States, although perhaps largely made from the iron ores of the island, other structural materials, such as stone and fictile deposits, are abundant. There are clays for all purposes, and limestone and ordinary marble for the construction of buildings. While the natives of the island have already thoroughly developed the art of using the clays for the manufacture of brick and tiling, there is no doubt that among the limestone deposits plentiful supplies of natural cement-rock will also aid them in their Spanish habit of covering buildings with stucco wherever it is possible. These limestones will be carefully prospected, with the great probability of finding large deposits of phosphate of lime, which will suffice to preserve the fertility of the island and more probably lead to considerable exports.

In short, it can be said that in addition to exporting quite a considerable amount of mineral produce, the island of Cuba could be successfully developed industrially from its own supplies of minerals were it not for the lack of coal, and the extent to which this desideratum will be supplied by petroleum and possibly by natural gas, as well as by the use of wood and charcoal, will be an interesting outcome of the future.

It is perhaps not fair to regard too seriously the obvious discredit of Porto Rico as a producer of minerals, which condition arises from her lack of mineral exports. This means that great mineral treasures will not be easily found on that island, or the work of restless American prospectors for hundreds of years would have revealed them long ago, no matter under what form of government. Geologically, Porto Rico resembles Cuba. We can think of it as a very high mountain, only a small proportion of which (4,000 feet) rises from the deep-sea floor to above the ocean level. Prof. Robert T. Hill, of the Geological Survey, who has just studied its mineral resources, describes it as consisting of three geologic elements: (1) A central system of deeply ribbed and corrugated mountains, with V-shaped gorges and ridges. In this region there are occasional dikes and hard, black, igneous rocks, and in the southern end this substructure is made up of granites, especially syenites. Near Mayaguez some serpentine rocks have been observed. (2) The lower hills around this central group form irregular bands along the north and south coasts. These are exclusively rock of sea origin, consisting of a peculiar type of tropical white limestone; loose-textured, chalky, marly, and shelly, and of different degrees of induration. (3) The third geological element consists of the Playa plains—alluvial soils composed of old reclaimed estuaries, extending from the seashore to the foot of the central mountains, across the line of foothills.

For hundreds of years gold has been washed in small quantities from many of the rivers, especially those of the north and east end. Fifty cents to a dollar a day represents the gain from a hard day's labor. The mother-rock of this metal has not been determined. Much delay in tracing the source of this gold will undoubtedly be due to the effort of the great number of American prospectors in seeking for quartz veins as its origin, of which there is no evidence. It is more probable that the vein-material is pyrite, the general geological conditions resembling those of Colombia and Panama more than the North American gold-fields. Zinc, tin, copper, mercury, manganese, and bismuth have also been reported, but not developed.

Nine tenths of the rocks of the island are of a basic nature, containing a large proportion of iron. Inasmuch as these are and have been undergoing oxidation and alteration, the conditions are theoretically favorable for the occurrence of valuable iron deposits, and in one or two instances Professor Hill states that these undoubtedly exist, notably north of Juncos. At this place there is a large deposit of high-grade magnetic iron ore very low in phosphorus. Its de-

velopment waits upon the construction of a railway. This deposit represents at present the one great claim of the island to mineral resources valuable for export. Further details concerning it will be found in Professor Hill's paper.*

Another likely field for prospecting is the magnetic sand so abundant in many of the stream-beds, notably in the western part of the island. Here many of the heavier minerals, such as platinum, monazite, tin, etc., may be sought.

As regards minerals for the development of the island itself, it is important to notice that coal is not altogether lacking, as in Cuba. Near Moca there is a deposit of lignite well worthy of development. In the western part of the island, near San Sebastian, there is an extensive formation of bituminous clay which contains a fair quality of lignite. Another specimen from the island had every aspect of a good cannel-coal, and it is believed that these fuel resources are worthy of careful study.

The surface of the mountainous portion of the island has been thoroughly decomposed and broken down into clays of all kinds, notably a red clay resembling that of the southern Appalachians. In fact, structural materials of every kind exist upon the island and have been utilized with great skill by the inhabitants. Besides brick and tile clays, excellent lime is produced from the white limestones of coast formation. The blue and gray crystalline limestones of the mountains are also well adapted for lime. Building-stone is plentiful, consisting of volcanic boulders of limestone; of porous, white, massive, quarrying limestone, and limestone flagging. The chief material used, it may appear strange to say, is of the first two classes named. Native masons excel in the art of constructing walls of this lumpy material, binding it solidly together with cement. Near Juana Diaz there is a belt of beautiful marble of great hardness, which is quarried into blocks. It is variegated in color, consisting of a reddish matrix mottled with numerous small white spots. At present it is used only for structural purposes, but it is fit for use as an ornamental stone. Fairly good grindstones are made out of some of the native rocks, although sandstone is comparatively rare on the island.

The salt industry, beds of gypsum, chalk, and silica for artificial cement will undoubtedly give employment to much labor in their utilization; but one of the most necessary latent mineral resources of the island consists of the natural fertilizers, such as gypsiferous and

*"The Mineral Resources of Porto Rico," Twentieth Annual Report of the United States Geological Survey.

green-sand marls in great abundance, and phosphate of lime. These, properly selected, will undoubtedly renew the fertility of many thousands of acres of abandoned tobacco-lands, and probably no more lasting benefit will accrue to the island from American occupation than the application of these neglected native fertilizers to exhausted lands.

The core and mass of the Hawaiian islands consist of volcanic rocks built up from the ocean floor in comparatively recent geologic times; therefore the mineral exports from them are somewhat like those of Porto Rico. The Hawaiian rocks range from basalt to trachyte, forming a complete series, from the most basic to the acidic, but consisting almost wholly of the more basic members. Part are quite fresh and part are much altered by the chemical action of weathering. As the volcanoes, ancient and extinct to the recent and active Kilauea and Mauna Loa, all rise from the deep-sea bottom to, in some cases, great elevations above the sea-level, they are the most notable examples in point of magnitude and interest known. Around the predominating basaltic eruptive rocks is the usual fringe of coral reefs. Some of these have also been elevated far above sea-level, and in disintegrating and then compacting, a calcareous sandstone has been formed, in addition to the coral limestone of the reefs in place. The Hawaiian volcanoes have been enormous laboratories, using the strong decomposing agencies of acid steam, high temperature, great rainfall, and possible sea-infiltration, so that secondary decomposition products are quite numerous. The most important secondary action has been with an acid solution from the volcanoes reacting on easily decomposed limestone, so that Mr. S. B. Dole has noticed among the minerals of the islands sulphur, pyrite, common salt, sal-ammoniac, limonite, quartz, augite, chrysolite, garnet, labradorite, feldspar, gypsum, soda-alum, copperas, glauber salt (sodium sulphate), niter, and calcite. As a rule these minerals have no economic significance, though a few minerals will be of possible value for export, and many will be of importance in local industries on the islands. Sulphur is found in white deposits on the sides and in pockets of the craters and upper slopes of recent volcanic origin. The quantity is so marked in one locality at Kilauea that it is known as the "sulphur banks." As a secondary mineral, pyrite is frequent, but so far not in veins or sufficiently segregated to form a base for acid-making. As a result of the action of the sulphur compounds on the limestone, gypsum occurs in very large deposits, some of it almost pure. The result of this secondary decomposition has been a considerable amount

of mineral paints of many varied hues. The habits of the people do not call for much construction in stone, but there is an abundance of available material of which but little has been utilized. In addition kaolin has been found in pockets of large size and sometimes very pure. Pumice-stone is sufficient in amount probably to justify exportation. Salt is abundant enough for the purposes of the islands. It is likely that the same experience in the pearl industry which will develop in the Philippines, will be extended later to the pearls known to occur in the Hawaiian islands.

At this distance and with the slight exploratory work which has been carried on in the Philippine Islands, the minerals that can be profitably exported are naturally best known. Mr. George F. Becker, in his recent investigation, has given a very clear view of the present mineral exploration in the Philippines, and has shown that gold is found in a great number of localities in the archipelago, from northern Luzon to central Mindanao. In most cases the gold is detrital, and is found either in existing water-courses or in deposits now deserted by the current. It is said that in Mindanao some of the gravels are in an elevated position and adapted to hydraulic mining. There are no data at hand which indicate decisively the value of any of the placers, but the fact that they are washed largely with cocoanut-shells for pans by the natives is an indication of either rich deposits or quite coarse gold. In the province of Abra, at the northern end of Luzon, there are placers, and the river Abra itself yields auriferous gravel. In Lepanto there are gold-quartz veins as well as gravels, and here also is the best-developed sample of copper ores, although these are also reported from a great number of localities on the islands of Luzon, Mindoro, Capul, Masbate, Panay, and Mindanao. This last island is practically unexplored and full of possibilities. The copper region at the northern end of Luzon is unquestionably valuable. Here copper ore had been smelted by the natives, even before Magellan discovered the Philippines. It is smelted in a remarkably complicated way, considering the antiquity of the work. The process consists in alternate partial roasting and reduction to matte, and eventually to black copper. It is generally believed that this method was introduced from China or Japan.

The existence of iron ore in abundance on Luzon, Carabello, Cebú, Pana, and doubtless in other islands, and the fact that a small industry exists in the province of Camarines Norte, on Luzon, where wrought-iron is made into plowshares at a sort of bloomary, brings up the importance of the fuel question aside from the need for a coaling-

station. There is coal in various provinces of the island of Luzon and on other islands. The finest beds thus far discovered appear to be those in the small island of Batan, lying to the east of the southern portion of Luzon. These seams vary from two to fourteen feet in thickness, and analyses show the coal equal to at least a good quality of lignite. Besides these, the coal-fields of southern Luzon and across in the northern portion of Sámar, in Mindoro, where there are large deposits, and Semirara, Masbate, and Panay, all will justify careful exploration, and especially promising are specimens from the southern portion of Leyte, and of remarkably high quality, although nothing definite is known about the deposit. On the island of Cebú are deposits well worth examination. A considerable quantity of coal has been mined there, and the occurrence of petroleum-springs and the reported presence of natural gas make this a likely field for exploration. Seams fifteen feet thick are reported from Uling, ten miles from the capital of Cebú, and such analyses as have been made indicate a fuel-value of about two-thirds of the calorific effect of Cardiff coal, with only about four per cent. ash. On the island of Negros, at Calatrava, there are also coals believed to be important, and coal is known to occur at eight different localities on the island of Mindanao. The presence of lignite is indicated from one end of the coast to the other.

Evidently the supply of fuel in the Philippines is promising, and, taken together with the iron and other metallic resources, would suggest that American metallurgists, instead of supplying this region from the United States by direct exportation, could more profitably export manufacturing plants.

But what is of more interest to the United States, as supplying what may be considered a lack in its own mineral resources, is the possibility of securing supplies of tin ore and of platinum metals from the Philippines, for, while it is probable that the United States may become a large producer of platinum in the near future, there is no question that the usefulness of this material will justify every possible search for it in the Philippines, and, from the geological conditions, with fair prospect of success. It is quite easy to exaggerate the desirability of new sources of tin for the United States. In fact, the attitude of most mineral-writers has been to overrate the desirability of tin mines in the United States. The metal has been given a higher place than it really deserves. It is not generally recognized that the supply of tin for America is neither limited to Cornwall nor dependent upon her mines for any considerable portion of what is used. The fact

PRODUCTS.	CUBA.	PORTO RICO.	HAWAII.	THE PHILIPPINES.
IRON ORE.	Sierra Maestra, a few miles east of Santiago de Cuba, chief metallic product.	Valuable deposits, notably north of Juncos; estimated to contain 10,000,000 tons metallic iron.		On the islands of Luzon, Panay and Cebú.
SILVER.	Mines in Santa Clara yielded in 1837 140 ounces to the ton; now worked out. probably not to be found in paying quantities on the island, and the same can be said with reference to gold.	Washed in small quantities from rivers in the north and east ends, notably the Luquillo and Loiza; also near Corozal.		On Marinduque and Cebú.
GOLD.				On Luzon, Catanduanes, Mindoro, Sámar, Bohol Libuyan, Panay, Cebú, Mindanao and Panaon.
COPPER.	Mined at Cobre, north of Santiago, from 1524 to 1867, and occurs in many places in the eastern part of the island.	Frequently met with in the central mountain region, but nowhere in great quantities.		On Luzon, Mindoro, Masbate, Panay, and Mindanao.
LEAD.				On Luzon, Marinduque and Cebú.
ZINC.		Found in small quantities near Malapascua.		
QUICKSILVER				Reported to be found on Panay and Leyte.
TIN.		Reported to have been found.		
PLATINUM.				On Mindanao.
COAL.	Does not exist upon the island.	Deposits near San Sebastian, in the western part of the island, and at Guatemala; lignite.		On Luzon, Mindoro, Carray, Baton, Rapu-Rapu, Masbate, Sámar, Semivara, Panay, Leyte, Cebú, Negros and Mindanao.
BUILDING STONE.	Limestone abounds everywhere; building sand of Havana is very fine.	Sandstone rare; limestone abounds from Guayama to Cabo Rojo; marble near Juana Diaz; granite near Fajardo.	Abundance of this material, especially limestone and sandstone, but not utilized.	Marble on Luzon and Romblon.
PETROLEUM.	Santa Clara.			On Panay, Leyte, and Cebú.
NATURAL GAS.				On Cebú.
CLAY.	For brick and roofing tile in abundance, especially in the eastern provinces.	For brick and potteries in abundance; a few potteries on the island, notably near Ponce.		Kaolin mined at Los Baños, in Laguna Province, on Luzon.
CEMENT.	Everywhere in abundance; also plaster.	Chalk, clay and silica for artificial cement abound in the coastal formations.		
MINERAL WATERS.		Several springs, the Quintana at Ponce, and the springs of Coamo.		
PHOSPHATE ROCK.		In abundance everywhere; guano deposits near Ponde.		
SALT.	In abundance along the northern keys.	Rich deposits at Coamo, Guánica, Sierra de Piñones de Cabo Rojo.	An industry of some local importance—sea salt.	
GYPSUM.		In abundance, central mountains north of Juana Diaz.	Very large deposits, some of it almost pure.	
MINERAL PAINTS.			Red and yellow ochre in abundance.	
GRINDSTONES		Fairly good made out of native rocks.		
ASPHALTUM.	Cardenas Bay; Villa Clara, large deposits, Havana Province.			
PRECIOUS STONES.			Pearls have been found, but not of commercial value.	Important pearl fisheries in the Sulú Archipelago.
PYRITE.		Found in central mountain region.	Occurs, but not in great quantities.	
FELDSPAR.			Occurs frequently.	
MANGANESE ORE.	Rich deposits Sierra Maestra and at Santiago, near Ponupo.			
SULPHUR.			Found around the volcanoes, notably Kilauea.	Abounds around the volcanoes, islands of Luzon and Biliran.
MARLS.		In abundance near Juana Diaz and near Ponce.		

is that the Straits Settlements, together with the islands of Banca and Billiton, yield all that the United States can possibly use, and a desire for tin in the Philippines should be but for the purpose of finding deposits even richer than those in the Straits, and where it would be easier to work them, under American conditions.

Another form of mineral treasure is the pearl-fishing in the Sulú archipelago.

It is evident that the export minerals alone would justify much prospecting in the Philippines. As to the other materials which are likely to develop the islands, much less is known; but it is evident that all varieties of building-stone are plentiful, and that the same conditions which have furnished valuable clays in the Hawaiian Islands and in Cuba and Porto Rico—the decomposition of granitic and other crystalline rocks—have furnished abundant material for constructive purposes in the Philippines.

In general, the report of Mr. Becker has shown fully as great mineral resources in the Philippines as were ever believed to exist. It is evident that the development of these islands will not be hindered by any lack of important mineral deposits.

The table on page 250 summarizes the present evidence of useful minerals in all the islands in question.

THE DEVELOPMENT OF WOOD-WORKING MACHINERY.

By John Richards.

THE operation of wood-planing by means of rotary knives or cutters involves such a diversity of applications that these must be classified in order to treat them in an understandable way. In trade-terms the machines are called timber-planing machines; planing and matching machines; and dimension, surfacing, and moulding machines.

The operations performed by these machines are the most important in wood-working, are also the most expensive, and may be divided, as above, into timber-planing, or squaring up rectangular sections of all kinds without straightening; dimension-machines, in which the timber is moved on carriages, made straight, and planed on one side at a time; planing and matching machines, adapted for preparing tongue-and-groove work, such as flooring, ceiling, and wainscot-boards, and for surfacing one or both sides of boards; surfacing-machines, to thickness and plane one or both sides of boards; moulding-machines, to prepare moulded sections of all kinds, also for grooving, rabbeting, etc.

In all the machines that plane on four sides at a time there is the remarkable difference between American and European devices that they are arranged oppositely in the order of the cutters, or in the course in which the timber is fed through the machines. This feature has been noticed before and will be observable in the illustrations, although at this time there is going on a gradual change of the American machines from the method followed in Europe, which is in substance the same as when material is planed by hand; that is, a "face" is first made on one side, then the edge squared from this face, and, as a final operation, the timber is reduced to an even thickness.

In the American machines, except in some of the later designs, the first operation is to thickness the timber, producing a surface that becomes the "face," but is not the face from which the other sides are planed. The side-cutting is gauged from the bottom or rough side, and a final operation is to cut away a constant amount on the bottom of the piece forming what should have been the face at the

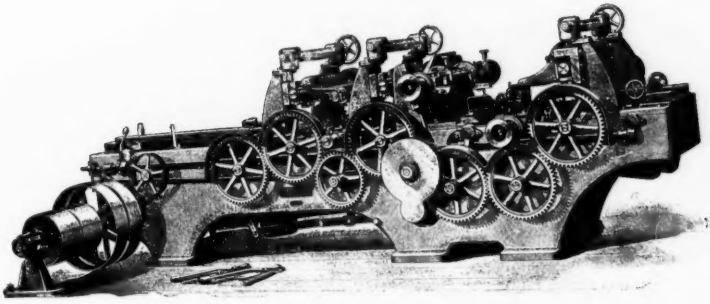


FIG. 1. HIGH-SPEED FLOORING MACHINE.

A typical American machine for producing matched and surfaced flooring in large quantities.

beginning. In this manner tongue-and-groove material is gauged from the back, and variations, or spots unplaned because of the timber being too thin, come on the front or face.

There are a number of objections to this latter-described manner of planing. The faces are not so good and are rougher, because of thicknessing at the same time; the main work is thrown upon the first cutters, and the mass of the shavings is deposited on the machine, interfering with the feeding-rollers, bands, side-heads, and gearing; the timber being dressed on its sides or edges when bearing upon an unplaned surface is unstable and does not bear solidly upon the bed beneath.

How such a difference in the arrangement of planing-machines came about it would be hard to discover at this day. The first

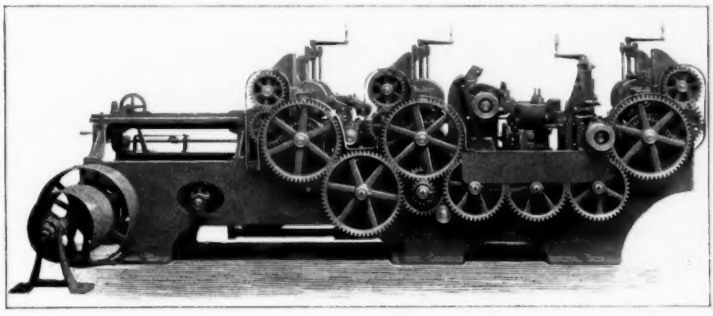


FIG. 2. PLANING AND MATCHING MACHINE.

For flooring and general planing-mill work.

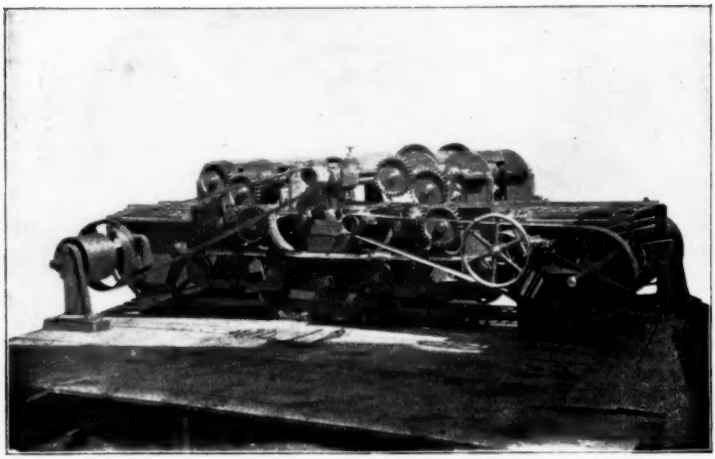


FIG. 3. HEAVY TIMBER PLANING MACHINE, ATLANTIC WORKS, PHILADELPHIA.

For planing four sides at one operation on timbers up to twelve inches square. A powerful and well-designed machine.

machines were made to plane on one side and the edges, and a third cylinder was added to plane the bottom. The theory of operating was not considered. The writer, himself long a designer and maker of such machines, failed to detect this difference between the American and European system of planing until by a misunderstanding he exported a heavy machine to Europe and it had to be returned as unsalable. There is now, as before remarked, a rapid change going on in the United States. Moulding-machines that had always operated the same as planing-machines are now commonly arranged with a facing-cutter to act first on the bottom of the wood, and many planing-machines are made in the same manner. In all other respects, fixed cutters excepted, the details and operative qualities of planing-machines have been thoroughly worked out by American makers, and various features have been extensively copied in other countries.

The advantage of fixed planing-cutters, common in all European machines for plain joiner-work, is the production of smooth surfaces ready for painting and varnishing. There is also the advantage that the rate of planing can be much faster when fixed knives are employed. Twenty years ago a common rate of planing floor-boards in the Swedish and Norwegian mills was 90 linear feet per minute, sometimes exceeding 100 feet per minute, but with machines opera-

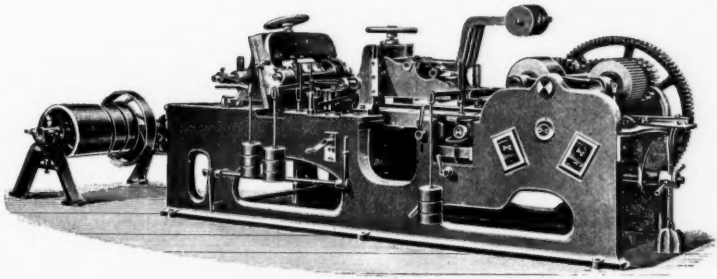


FIG. 4. GENERAL MATCHING AND PLANING MACHINE.

A typical machine of English design, with fixed knives in addition to rotary cutters.

ting with rotary cutters alone the rate of working was much slower than in the United States, because such cutters were driven at a lower rate of speed; besides the wood was more difficult to work.

The market standard for joiners' material is a matter that to a great extent governs the method and rate of planing. In the great cities of Europe—London, Paris, Berlin, and Vienna, for example—mouldings, doors, sash and matched stock of all kinds, has to be smooth in order to be sold, and this causes careful working in the mills and factories of northern Europe.

The subject of working smooth surfaces is one of paramount interest in the United States at this time, and should have the serious consideration of manufacturers of joiners' materials who desire to found an export trade, now to some extent established, in doors,

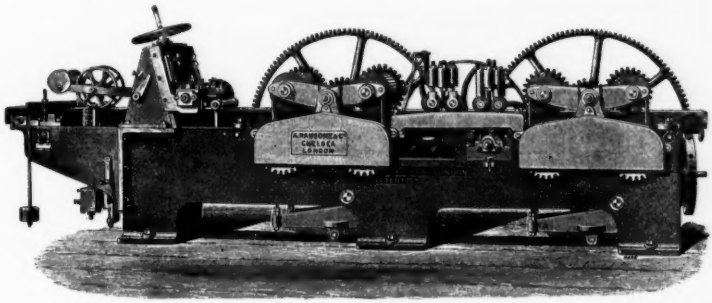


FIG. 5 GENERAL TIMBER PLANING MACHINE.

A good example of English practice, using both rotary cutters and fixed knives.

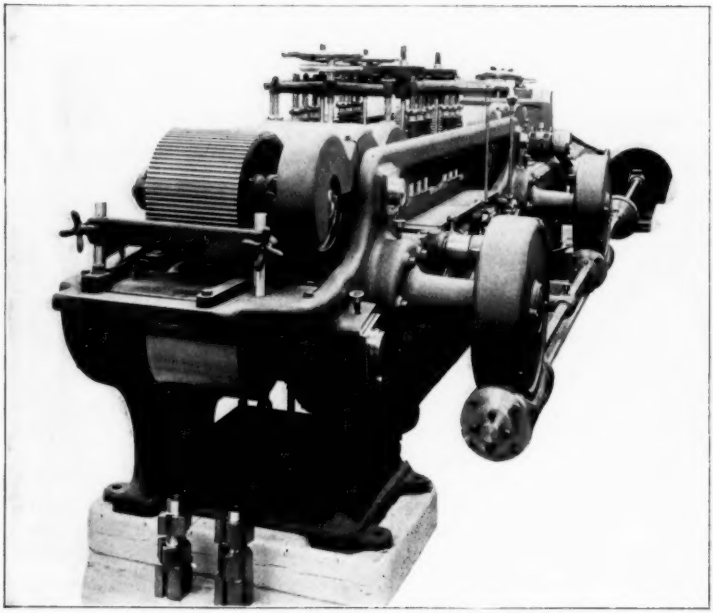


FIG. 6. HEAVY PLANING MACHINE.

Swedish planing machine, showing feeding end.

sashes, blinds, and other things that can be smoothed by sand-polishing machines.

The main articles of export trade should be mouldings, flooring, ceiling and covering boards for painting or other finish, but the present method of planing in America does not produce material that can compete with European mills, such as there are in Sweden and Norway, and as these people have drawn extensively upon American practice in the finishing-class of machines, such as those for mortising, tenoning, irregular moulding, turning, and so on, it would be fair and an easy matter to procure their illustrations of joiner-work for portable buildings, doors, sashes, and the like. Of course there would have to be, to some extent, a new adaptation of machines and processes. A French window, for example, is hinged at the sides, with a weather-proof overlap between the two sashes, which are made much longer than in the United States. The doors are heavier, longer, and differently made. German styles are differ-

ent from these again, but the prices paid for such work are much higher than in America, and warrant the expense of special designs.

Tongue-and-groove flooring is regarded as a cheap expedient and wasteful of timber, also limiting the rate of planing. Export flooring, it will be found, requires straight edges, precisely square, so as to be keyed up solid and made impervious to water or air.

Fixed knives were once attempted in the United States as a means of avoiding the notorious Woodworth patent, on rotary planing-machines, but could not succeed as a sole means of planing. It is essentially a supplementary smoothing process to cut off a thin shaving and remove the marks left by the rotary cutters. There seems to be no difficulty in maintaining these fixed knives. They have, of course, to be kept in good order, but are set in "drawers" that can be pulled out and fresh ones set in without stopping the machines. The illustrations will explain this.

It is remarkable that in America, where fixed knives are seldom used for planing, and not at all in large planing-machines, abrasive smoothing or polishing machines should have had such complete development. Rotary-drum sand-polishing machines are now found in all the principal joiner-works in America, employed for all kinds of parallel-work that has to be "cleaned off."

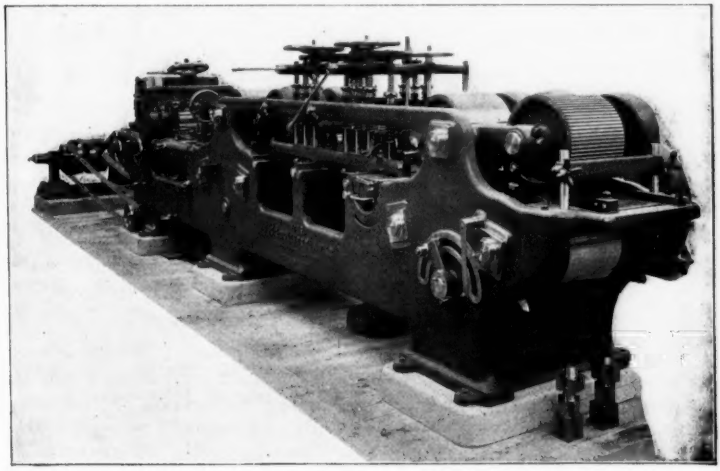


FIG. 7. HEAVY PLANING MACHINE.

A fine example of Swedish design, using roller feed, with fixed and rotary cutters.

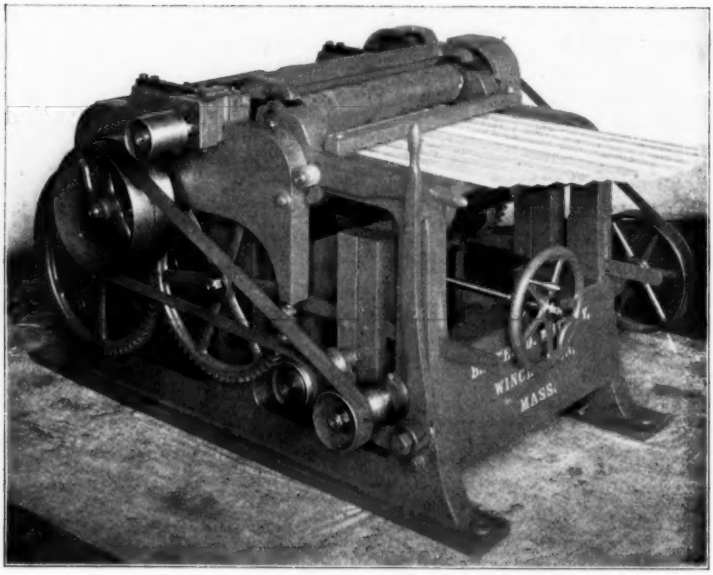


FIG. 8. WHITNEY SURFACING AND THICKNESSING MACHINE.

A remarkably fine machine. The adjustable bed is mounted on inclined planes, giving a very firm support.

There is variation in the practice of making joiner-work, as in all kinds of industry. In some portions of the United States planing is more carefully done, especially where the timber is bad. On the Pacific coast, where material is remarkably fine and clear, the worst planing is done. There is no outside competition to raise the standard of the work. Tongue-and-groove work, such as flooring, ceiling, and wainscoting, is often planed green, with a result that can be imagined, and mouldings are usually planed so rough as to require sandpapering to remove the cutter-marks. Flat surfaces, such as ceilings, have to be replaned by hand if a smooth surface is desired. This is a common result of local competition, which causes a reduction of prices below what will produce first-class work, and prevents investments in machines of the best class. A surfacing-machine that costs $400 is not likely to do the same work as one worth $800, and a flooring-machine at $600 is a very different machine from one costing $1,200 to $1,600. They are made with these variations in price, all directed to the same kind of work.

American makers of planing-machines, while they have not attained with rotary cutters the smoothness that fixed knives will produce, have attained with rotary cutters surfaces so smooth that planing-marks are not discernible. It is true that this result can not be produced with cheap or fast-feeding machines, but there are many made that operate in an excellent way, especially those designed to surface both sides so that the second or facing cut is made after the timber is thicknessed. Provisions to produce smooth working of rotary cutters are: (1) solidity of all parts, to prevent rhythmic vibration—that is, a firm bed, a cutter bar or cylinder of considerable weight and inflexible, with its bearings well fitted; (2) pres-

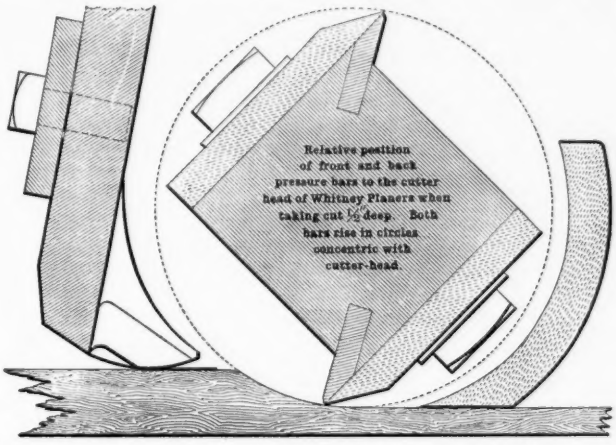

Relative position of front and back pressure bars to the cutter head of Whitney Planers when taking cut ½ deep. Both bars rise in circles concentric with cutter-head.

FIG. 9. SECTION OF CUTTER-HEAD AND PRESSURE BARS.

sure-bars that firmly hold the wood close up to the cutters, both in front and behind them; (3) a high speed, to prevent synchronous vibration of any portion of the machine; (4) a movement or feed of the material that permits from twenty to thirty cuts per linear inch.

Fig. 9 is a true section through the cutters, cutter-head, and pressure-bars of the machine shown in Fig. 8, which has produced the smoothest work known to the writer, also the greatest reduction of thickness, as was noticed in the first section of these articles. The maker gives the following description of this device:

The front pressure-bar is made of cast-iron fitted with a flexible spring extending the whole length of its lower edge. Through this spring the weight of the pressure-bar is brought to bear uniformly upon the piece being planed.

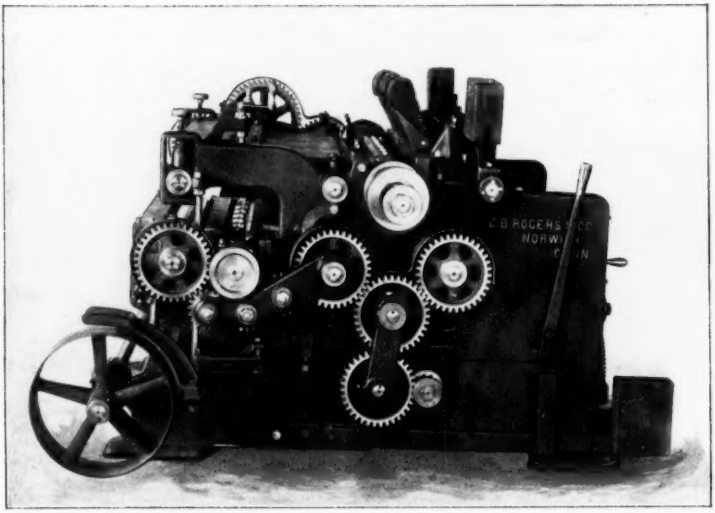


FIG. 10. SURFACING AND THICKNESSING MACHINE.

With under cutter at the rear.

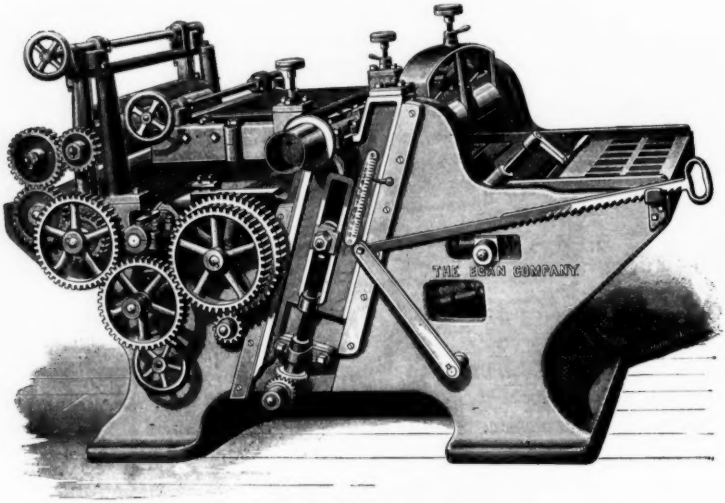


FIG. 11. ENDLESS-BED SURFACING MACHINE.

The wood is fed by the traveling slat bed, and a pair of feeding-out rolls deliver the finished work.

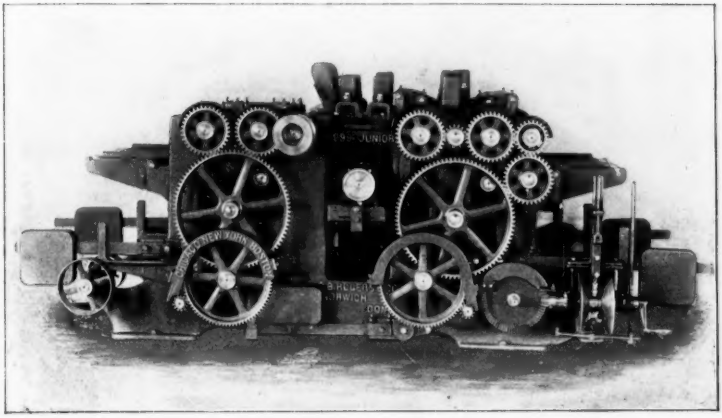


FIG. 12. HEAVY DOUBLE SURFACING MACHINE.
To work both sides, up to 30 inches wide and 12 inches thick.

The edge is flexible, and thus fits into all irregularities of the surface and presses the timber firmly to the bed. When occasionally an unusually large hump or ridge in the stock bends the spring unduly at any point, it curves around the fingers projecting from the back of the pressure-bar until the bar itself rests on the stock, preventing breaking of the spring and interference with the knives. The bar is entirely automatic in its action and presses the wood at a point which is always the same distance from the knives, whether the cut is light or heavy.

The back pressure-bar is made of steel. It is rigid and is pressed upon the stock by springs from above. The flexibility required in the front bar is not necessary here, because the wood has been brought to a uniform thickness before reaching this bar. These two bars acting together hold the wood to the bed at a distance of only 2¼ inches apart when light finishing-cuts are being taken.

For hard wood alone the maker would no doubt change the angle of the cutters and set them more obtuse, but as the work of such machines is commonly divided between hard and soft woods, adaptation in this respect must be a compromise.

Besides the typical designs shown in the drawings, machines of this type are made in great variety of form not necessary to illustrate. They consist essentially of one or two cutting-cylinders, feeding-rollers to move the timber, and pressure-bars to hold it down. In some cases the machines are made with endless-chain tables beneath the cutters, dispensing with feeding-rollers. The type is American, and those made in Europe are usually imitations of or adaptations from American designs.

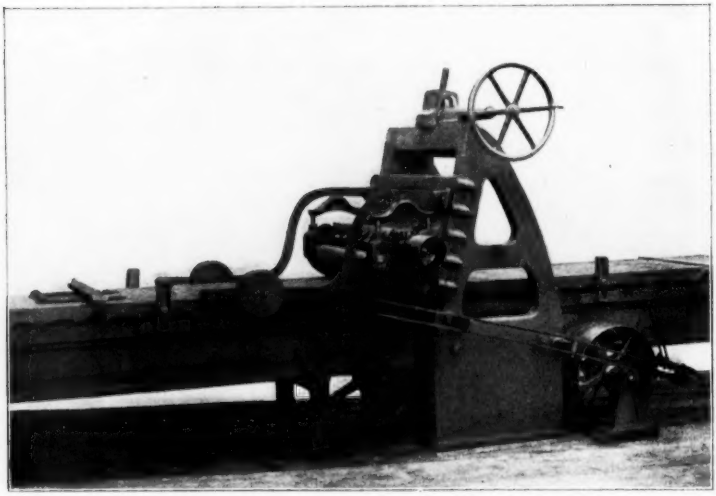


FIG. 13. DIMENSION PLANING MACHINE.

The bed travels back and forth on planed ways.

Carriage Planing Machines are the oldest machines, dating back to 1802 or earlier. Their operation is distinct from that of all the machines that preceded, in that they plane in straight lines, the timber being guided by a carriage and not from its own surfaces. This type of machine, it may also be said, is to plane inflexible timber, while all roller-feeding machines are presumed to plane pieces that are flexible. Of late years the carriage type of machine has been substituted to a great extent by the continuous-feeding kind, because of the faster and cheaper performance of the latter. In fact such substitution has gone far beyond the point that good work demands. In joiner-work as well as in many kinds of frame-work the parts can be forced together by nails or bolts if the section is uniform, but for large pieces it is desirable that they be planed straight.

The carriage planing type of machine is divided into two classes —one in which the axis of the cutters is parallel to the faces to be planed, the cutters being the same as those employed in the continuous-feeding machine; the other class, sometimes called transverse machines, have the axis of the cutting-motion normal to the faces being planed.

It would consume a good deal of space to analyze the difference

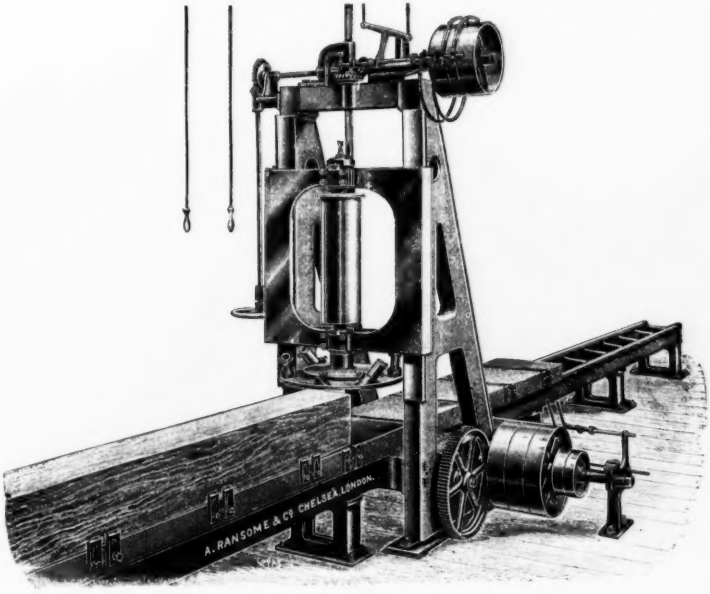


FIG 14. ENGLISH TRANSVERSE PLANING MACHINE.

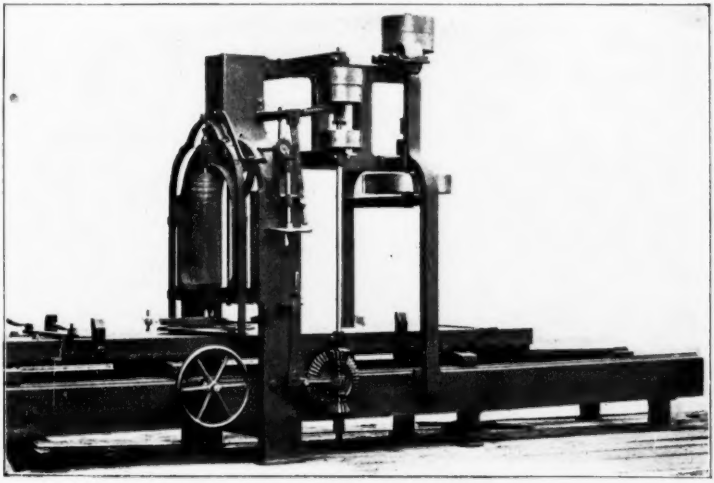


FIG. 15. AMERICAN TRANSVERSE PLANING MACHINE.

between these two methods of planing, and would be without a corresponding advantage. Two transverse machines are shown in illustrations chosen, exhibiting the American and the European practice. The "dimension" machines are American in their origin and were a successful effort to increase the rate at which the traversing-machines could operate, producing smoother surfaces, but less true, because of the timber being exposed to the strain or concussion of the edges acting at the same time across the whole width of the piece. The transverse class operate with narrow edges, not

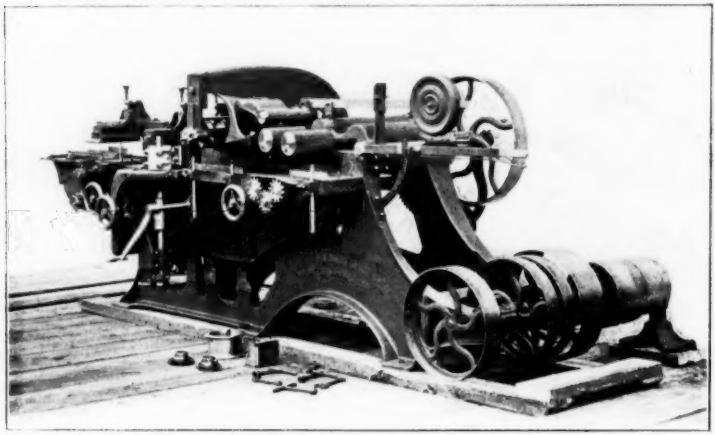


FIG. 16. OVERHUNG MOULDING MACHINE.
Commonly called a "sticker," and adapted for producing a great variety of mouldings.

over half an inch wide, across the timber, and cause but little disturbing action, and consequently perform truer work. Machines of this kind are employed in machine-pattern shops, and for work that is to be glued together, also for accurate framing, or for any work that requires to be "taken out of wind" as it is called.

A moulding-machine for wood-working is essentially a small planing-machine for other than rectangular sections. In the United States the line of distinction from planing-machines is more marked, because the majority of American moulding-machines are made with overhung cutter-heads, commonly called outside moulding-machines, and because of the fact that the same machines are seldom employed for two purposes, that is, for moulding and planing. In European practice the two operations are so nearly related, for

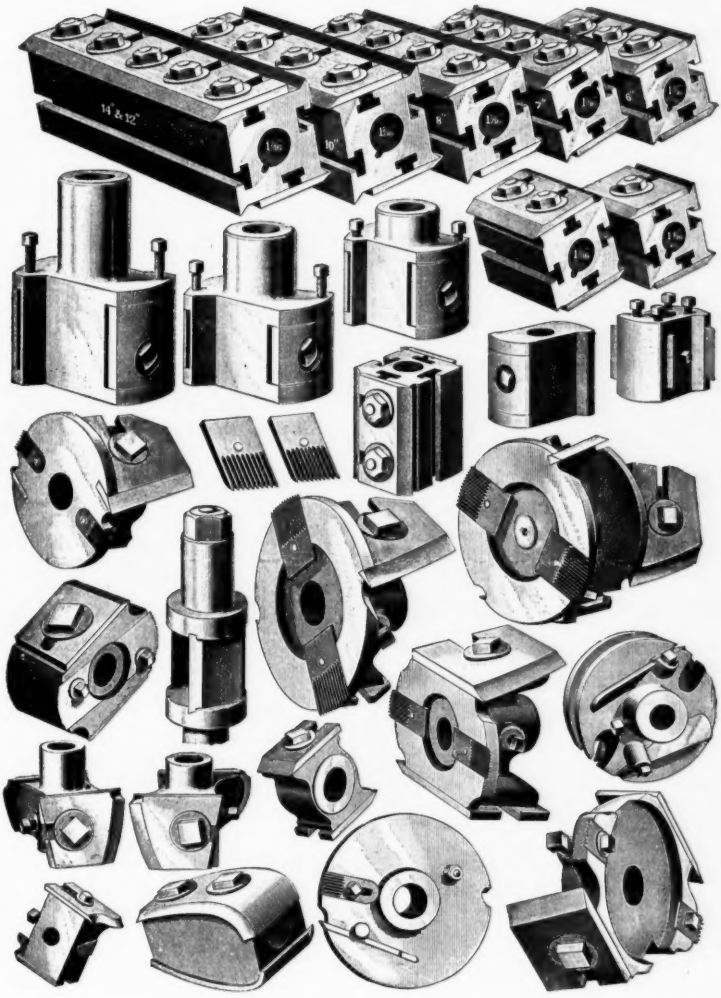


FIG. 17. EXAMPLES OF AMERICAN CUTTER-HEADS

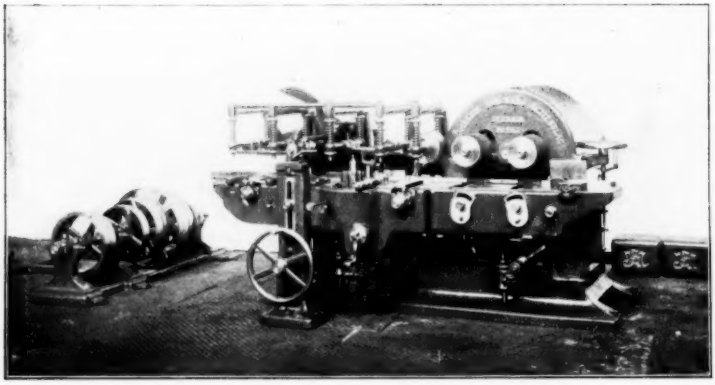


FIG. 18. OVERHUNG MOULDING MACHINE.

A Swedish design, resembling somewhat American practice. Five cutter-heads are used.

reasons that need not be gone into here, that the moulding and planing machines merge into each other without any clear points of distinction. In fact, the same machines are employed for either purpose, or, as we may say, for sections of any kind. The necessary distinctions are in provision for conveniently changing the cutters and in a wider clearance of pressure-bars and other devices to support the timber; also, in most cases, more cutters are required when the figures or sections of mouldings are complicated.

Many of the preceding remarks respecting planing-machines apply alike to moulding-machines, especially as to the order of the cut-

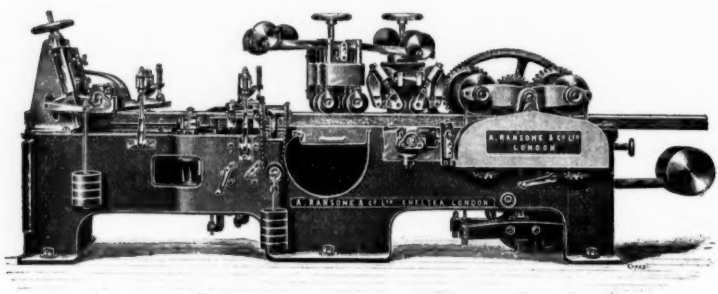


FIG. 19. HEAVY MOULDING MACHINE.

Arranged with revolving moulding cutters above, and fixed smoothing knives below.

ters, which forms a second principal distinction between American and European practice. It has not been possible to find many examples of American moulding-machines among the illustrations where a bottom cutter acted first to form a face, and none where the main top or proper cutters acted last. Notwithstanding this, the writer is aware that a general change is going on in this arrangement of the cutters, and that a facing-cutter acting first on the bottom is becoming common with nearly all the makers.

In European machines, as will be seen by the few illustrations given, the order of the cutter is, first, a bottom one to make a face by which subsequent working is gauged; next, the sides are worked; and then the main top profile is made by the last cutter. In American machines the main profile-cutter acts first, then the side-cutters, and finally a bottom cutter at the rear of the machine. In other words, the arrangement is reversed, or the timber is moved in the opposite direction.

The difference and advantages of these two methods of arrangement has been to a considerable extent discussed previously in connection with planing-machines and need not be gone over again, unless it be to say that if moulding-machines are to become an article of export trade, like many other kinds of wood-working machines, it will be necessary to arrange the cutters oppositely, as indicated, because it seems to be a logical system of operating and one not likely to be changed in future, and is also one that can not be objected to in the United States, especially for that class of machines called "inside" moulding-machines, wherein the cutter-spindles are supported at each end or at each side of the work.

Besides the various types of planing-machines illustrated, there are in common use hand planing or jointing machines that serve a useful purpose. They had their origin as distinct machines in America about twenty years ago, and are in fact a division of what are called universal wood-making machines in the United States, and general joining-machines in England. They are essentially inverted hand planers or jointers, in which a rotary power-driven cutter takes the place of the plane iron or knife.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

V.—THE DEVELOPMENT OF TRADE UNDER COMPETITIVE CONDITIONS.

THERE are peculiar conditions affecting the development, introduction and general adoption of high-grade machine tools in Europe. The most potent factor with which the wide-awake manufacturer has to deal, in introducing new machinery, is the indifferent, non-ambitious workman. He opposes the introduction of improved tools, and rarely suggests a new device, or a labour-saving appliance, by which work can be cheapened or improved in quality. Almost invariably the progressive employer has to force his men to work a new machine. It amounts to this,—that from the great body of workers in Europe few improvements emanate. The workmen demand little or nothing from the machine-tool makers, except the devices their forefathers used; they rarely originate, and they absorb reluctantly. They are, on the whole, a massive, inert stumbling-block to mechanical progress. To say that labour-saving machines, or new methods, can always be introduced, with ease, into American shops would be wrong; but the general spirit among American mechanics is to get the most out of a machine or tool and to improve it, if possible. The tendency among European mechanics is "to make the job hold out," and there is so little coming from them in the way of suggestion or desire to increase output that their attitude largely influences the policy of European machine-tool makers. I am speaking of conditions, not of causes, many of which work to produce this state of affairs, and not the least of which is the management and supervision under which European mechanics work, by which suggestions and improvements are not encouraged or rewarded, but in many cases actually resented. The conservatism of manufacturers and the pig-headedness of trade unions also have a great influence on the development of machine tools in Europe. The constant effort to save, even the smallest fraction of time, in the handling of work (due as much to the commercial as to the mechanical instinct of American makers of machinery) has been the means of developing the automatic machinery made in America, and now being so largely

adopted throughout the civilized world. The American manufacturer is never satisfied until one man is attending as many machines as possible, or until each machine is turning out its maximum product. He demands more from the machine-tool maker than does the European manufacturer. He expects and receives assistance in the way of improvements, by which he can cheapen his products and improve the quality. Generally speaking, European manufacturers do not keep so closely in touch with makers of labour-saving machinery and improved tools as do American; they are not so well posted as to the latest designs; they stick to this or that maker of lathes or milling machines, and are with difficulty induced to transfer their patronage. They have been well served for the last fifty or sixty years; why disturb the routine of office work by introducing a new name into the books? Old age has its disadvantages. Many European manufacturers are buying obsolete and antiquated machinery for purely sentimental reasons. Business connections between manufacturers and machine-tool makers are still maintained which were established as far back as the time when American manufacturers were buying machinery from England. Such ties are not easily broken. In this light the, to an American, exasperating conservatism of many European manufacturers is easily explained. It would be well if Americans who are seeking a market in Europe for their machinery would try to realize the situation, historically. It has been centuries in developing, and cannot be as rapidly changed as Americans may suppose. The field for American machinery is big; it requires careful cultivation, but the harvest is sure. In the development of automatic machinery the American undoubtedly has, so far as domestic trade is concerned, the advantage of European makers, who are restricted by the conservatism of their customers, dictation from trade unions, and the customs of their forefathers. He also has the advantage of being free to make practical applications of changes suggested by actual experience, regardless of the dogmatism of professors and unpractical technical men, who so largely influence the commercial policy of many European manufacturers. Another condition with which European machine-tool makers have to contend, but is of comparatively little importance in America, is the stagnating influence of government orders. For well-known reasons government workshops are notoriously slow and out of date. The cumbersome, lifeless methods of government transactions are far-reaching, and their influence extends to private workshops which receive enormous orders for war materials. Many English and con-

tinental machine shops are largely affected by government contract work, which cannot be given outside the home country. This state of affairs does not compare favourably with conditions in America, where machine shops are supported under normal competitive conditions, and receive comparatively little patronage from the government. On the one hand, we have the exacting conditions of sharp competition; on the other, the deadening influence of government stipulations. The time must come when manufacturers cannot possible harbour within their walls engineers and workmen who will have anything but the latest and most highly productive machinery. Such conditions practically exist in America; they are slowly approaching in Europe.

Another important factor which influences the machine-tool business of England, especially, is her immense colonial trade with India, Australia, Canada, and Africa, which have been conquered, settled, and controlled by Englishmen. For years machine tools have been sent to the colonial possessions with little competition from outsiders. The colonial industries are owned and operated by Englishmen, who have little opportunity of becoming acquainted with the latest practice. Consequently they demand the same equipments as they have always been supplied with from the mother country. The producer of machinery at home receives from them few of the suggestions which should come from well-informed and progressive customers. Enormous quantities of English machinery are still being sent to colonial customers, who have little knowledge of the German or American article. France is still largely ordering machinery from England, and American makers well know that there they have made less progress than in any other European country of note. As soon as machinery from other nations begins to be more extensively introduced where heretofore nothing but English has been used, then will the English maker be forced to change his designs, and to offer machinery which must compete with the best the world can produce. Germans and Americans are now sending machinery into English colonial possessions, and, in the end, the effect will be beneficial to England, while her commercial supremacy will surely remain paramount for years, in spite of the repeated statement of well-known Englishmen that their countrymen are liable to be beaten in the commercial race, owing to the better education of the Germans. Having had considerable experience in both England and Germany, I find it difficult to trace this idea to its origin. Like many other popular bugbears, it probably emanates from the politi-

cal platform,—hatched in the brains of those who have had no opportunity for first-hand observation, and simply know that Germany is becoming a lively competitor. I believe it is not true to say that Germans are better educated than Englishmen. They are differently educated,—notably, in the acquirement and use of foreign languages. German manufacturers have the qualification of rapidly adapting themselves to the requirements of customers. At the same time, the German is more rapidly assimilating new ideas than the Englishman. As to real commercial supremacy, however, Germany is in its childhood, compared with England. A large English manufacturer, who is, by the way, a naturalized Englishman of German birth, tells me that he employs many German clerks, but nearly all are under thirty years of age. For the more responsible duties, which come with later years and greater experience, he prefers Englishmen. German education and training produce diligent, painstaking, routine workers and highly-trained specialists, but it seems not to turn out a great number of independent thinkers and practical men,—at least, as far as mechanical affairs are concerned. England has nothing to fear from Germany, if she will but awaken to the fact that her workshops need renovating. In natural resources she is the equal of Germany. In social institutions, which more or less determine the efficiency of workmen, she is the superior. She is not leading Germany, however, in capitalistic enterprise and the adoption of improved machinery. It is to America that England must look for a formidable competitor. There she is outrivaled in every instance but one—foreign trade. In natural resources she is far behind America. In efficiency of workmen she is far behind. She can hope to compete with America in but a few instances. She can compete with Germany easily, if, instead of harping on the superior training and education of the German workmen, she will set about the reform of her workshops and adopt machinery by which she can improve the quality of her manufactured articles and reduce their price.

It is, of course, of interest to American makers who are sending machinery abroad, as well as to the progressive European engineer, to speculate as to the market which exists for good machinery in Europe. Unless a severe general business depression occurs,—which, of course, no one can foresee,—the great quantity of high-grade American machinery which has been sent to Europe, and is still being sent, will appear but a drop in the bucket compared with what should be purchased before European manufacturing establish-

ments can be compared with American. As already stated, it is impossible for an American to understand how so many European manufacturers thrive while still working with old-fashioned machinery, out-of-date methods, and antiquated tools. The use of hand-tools, rough machine work performed on primitive machines, and lack of tool-room appliances, are common, and must be changed; rational methods and new equipments must be adopted. In other words, machinery must be ordered,—lots of it,—for years to come; for the awakening will, in many cases, be slow. With the exceptions, in England, of locomotive works, marine works, and some lines of textile machinery, and, in France and Germany, of military equipment, the workshops of Europe must, generally speaking, be re-equipped from beginning to end, if they would meet American competition. Of course, this cannot be literally accomplished, but the fact of the necessity exists, and it shows what the European market for good machinery means. The chances for American makers to supply a great deal of this equipment are good. They are technically better fitted, with but few exceptions, to deal with customers than is the average European maker. They can advise purchasers as to suitable machines and tools, which are being successfully used in the United States for making articles similar to those that may be in question, by manufacturers who are, as a rule, far in advance of the European manufacturer. Most of the leading makers of machinery in America now have, in a way, the advantage of the European maker, as they know the situation on both sides of the Atlantic. The writer personally knows representatives of more than twenty prominent machine-tool makers who, for some time, have been visiting European countries once or twice a year. The same enterprise is not shown by European machine-tool makers in cultivating the rich territory so near at hand. All leading American makers have agencies established in the more important European countries, which are now as well known as the best local engineers. A majority of American machine-tool specialists, who confine themselves to the manufacture of a limited line, and, in some cases, to one article, are sending from one-third to one-half of their product to Europe Without doubt, the introduction of so large quantities of American machinery into European markets, during the last three or four years, is somewhat due to the business depression which has affected America for some time, while the engineering business in European countries, during the same period, has been marked by a special activity. The American manufacturer was not slow to

take advantage of the demands in the European markets, in order to offset adverse circumstances existing at home. The American machine-tool maker has been forced to widen his field of enterprise in order to keep his works going, and to dispose of a product not demanded by home consumption. The European market was in a favourable condition; he took advantage of it, and has gained a position abroad which he will never lose. He has made use of American methods of selling machinery, to which the European buyer was not accustomed, but which he has readily accepted. With the certainty of a large market, it is curious that American machine-tool makers, especially the large firms, do not follow the methods of securing business abroad that they so successfully employ at home. I mean the establishment and maintenance of branch houses, managed by engineers who work solely in the interest of their own companies, understand advanced methods of manufacturing, and can make an application of their knowledge to the European situation. If the American wishes to succeed in Europe, he must study his customers by coming directly in contact with them. This is even more a necessity abroad than at home, as the situation in Europe is not yet thoroughly understood by American machine-tool makers, and presents more difficulties than they encounter at home. In America the machine-tool maker is favoured from the side of his customers, who demand highly-developed machinery and the most advanced labour-saving tools. The manufacturer is seeking to reduce the cost of production,—not primarily to buy his machinery as cheaply as possible. With European buyers the reverse is too often the case, and the price of machinery for producing the article is too frequently the most important consideration. Again, the idea of interchangeable manufacture of articles, of every description, is more thoroughly carried out in America than in Europe. The main idea is machine work, and to have the parts made to gauge and finished throughout by machinery. This, of course, favours and encourages the development of, and increases the demand for, labour-saving machinery, as against European conditions, under which articles are finished so largely by hand, with no system of gauging and inspection to secure uniformity in dimensions. There is a good field for the mechanical missionary in Europe.

With unsurpassed natural resources, the most efficient and cheapest labour, and the most highly-developed machinery, it is a pity that the political policy of the United States offers no more encouragement to foreign trade. The government shows no understanding of

the commercial and industrial situation abroad, and manufacturers and workmen are still humbugged by the stay-at-home politician, to whom the sweetest music is the screech of the American eagle, and whose dearest delusion is the necessity of nursing "infant industries." It is curious how American manufacturers allow themselves to be saddled with a policy which so deeply affects their foreign trade, and is not, in any part, tolerated by them in their domestic transactions,—a policy which shuts out competition—the great stimulant to improvement—and the frèe exchange of goods, which is an absolute necessity to commercial prosperity. In the first place, America has no need whatever for a protective tariff; secondly, she should promote the goodwill of foreign nations by removing all restrictive legislation against the importation of the very few articles in which there is competition. As to 90 per cent. of the manufactured articles used by civilized people, America is beyond the competition of any nation. Why should she seek to put other people on an unequal footing in commercial transactions by imposing a tariff, even on the 10 per cent. in which competition is possible? America is now talking about foreign policy, colonial possessions, and Anglo-American alliance, while all the time saying to others: "Please buy our goods, but we will not take your goods unless you pay us a tax of from 10 to 60 per cent." There is a strong retaliatory feeling in Europe against American machinery (and other goods, for that matter, as well), due solely to the high tariffs imposed upon European articles imported into the United States. Removal of these tariffs would do much to secure the goodwill of a customer whose wants are enormous, and whose wealth is sufficient to supply those wants. Compare the attitude of the United States with that of England, whose political policy goes hand in hand with her commercial interests, and compare the results. In 1895 the total foreign trade of the United States was less than that of Germany and one-half of that of the United Kingdom. The total export trade of the United States for 1890-1894 was, per head of population, less than one-half that of Great Britain, and below that of either France or Germany.*

America is to-day, however, sending more goods to England than France, Germany, and Holland put together, and, as an exporting nation, stands second only to Great Britain. Many interesting deductions are possible from the above facts. Progress in foreign trade has been slow, when it should have been rapid; it has been

*Armitage-Smith, "Free Trade Movement."

made in spite of a protective tariff, not because of it. The most important deduction, however, is that, as far as the machine shop is concerned, America, with her undoubted industrial supremacy, has a large foreign market, in Europe and elsewhere, for machine tools, which is not developed proportionately with her population and resources. It can easily be tripled. It is also evident that her political policy must, in the future, be commercial; not of the narrow domestic sort, that has so far prevailed, but of the broad cosmopolitan nature which is exemplified by England alone. By upholding a protective tariff the American government utterly ignores the first principle of trade—unrestricted exchange of commodities. Instead of protecting herself, she restricts the importation of certain foreign-made goods, which, if sold, add to the purchasing power of other nations which, by reason of unfortunate circumstances are not likely to become competitors as to even 10 per cent. of the ordinary articles of commerce, and never will compete as to those composed of steel and iron. It is difficult to refrain from commenting on the protective policy of France and Germany, which is so largely copied by America. The stupid humbugging of the Agrarian party in Germany is literally swindling the workingman out of his bread and butter. If the free importation of food-stuffs were allowed in Germany, the working power of her mechanics would be materially increased. What is particularly lacking in the German workman's diet is meat. The sustaining qualities of nitrogeneous food should take the place of the stimulant, beer, and they probably would, in part, if importation was encouraged. Even with high tariffs and foolish political agitation, Germany cannot shut out the importation of food entirely. There are certain lines in which Germany leads the world, and probably will, on account of natural conditions, but she can never hope to in agricultural products. Her working classes are badly fed, and she should open wide the doors to any nation that would supply food cheaply. If this were done, it would, with the rapid progress she is now making and the enterprise shown by her capitalists, materially assist her as a formidable competitor of England, 70 per cent. of whose exports are manufactured articles and 70 per cent. of whose imports are foods. It should be remarked, in passing, that in no country in the world is bread, the chief article of diet of the workingman, so cheap as in England.

It is of particular interest to the European manufacturer of machinery to note the costs of, and the time taken in, the transportation of machinery, particularly between England and continental coun-

tries, as compared with the same between the United States and Europe. Machinery ordered by cable from America is, as a rule, delivered in English ports in from 10 to 14 days; in German ports, in from 14 to 20 days. Fourteen days are usually consumed in transporting machinery between Berlin and London,—a 24-hour journey. The freight rates between the same points are double those charged for the same goods when transported from New York to London, Liverpool, or Hamburg. This state of affairs is of great disadvantage to European makers of machinery. I know many instances where the time consumed in transportation has alone decided the placing of orders with American makers. It seems impossible to move the cumbersome State railway management of Germany and France to reform in this respect, and, according to all indications. America will remain, for a long time to come, on an equal footing with European countries so far as cost and time of transportation are concerned, in spite of the fact that she is three thousand miles away.

PHYSICAL AND COMMERCIAL ASPECTS OF THE WORLD'S SHIP-CANALS.

By E. L. Corthell.

THE severance of the American isthmus seems assured, and with the completion of an adequate and easily navigable ship-canal from the Atlantic to the Pacific will come changes and expansions in the commerce of the world which can, as yet, scarcely be conjectured. Experience has amply proved that increased facilities create new traffic, greater as the gain in time, safety, or facility becomes more considerable. In a case where the change is so great and far-reaching as that which will be made by the completion of a trans-isthmian water-route, data of existing tonnage carried are of little value as a guide to an estimation of the traffic or the financial profit of the undertaking. Some suggestion, however, may be found by the study of other works of similar character, bearing always in mind that ocean freight-carrying is not much benefited by small savings in time of transit, especially when effected at the cost of more difficult navigation, while the gain from a large saving rises in rapid ratio. No inference can be drawn except by comparison of cases in which the main conditions are generally similar.

With the purpose of giving general data in a department of engineering work which promises to be so active for some time to come, I have prepared this brief review of the history, physical conditions, cost, commercial aspects, and other features of the principal ship-canals of the world.

SUEZ CANAL.

Napoleon I., when First Consul, ordered a survey between the Mediterranean and Red Seas. In 1847 careful levellings were made, establishing the fact of a common level between the seas. The tidal range is about four feet in the Red Sea, and less than one foot at Port Said. In 1852 Count Ferdinand de Lesseps proposed the Suez Canal to Abbas Pacha, Viceroy of Egypt, who did not approve of the project. In 1854 he submitted it to Said Pasha, the new Viceroy, who approved. Political opposition of the British Girt began at this time and continued to near the end of the work, greatly increasing the cost. In 1858 a company was formed, with a capital of $40,000,000, which began work in 1859. The opposition of Great Britain com-

pelled the Viceroy to withdraw the fellaheen, or native laborers, in number about 25,000. The canal was sufficiently advanced in 1869 to celebrate its formal opening.

The route follows the depression of land extending across the Isthmus of Suez, or nearly the shortest line between the two seas, and runs almost due south. About 60 per cent. of the total length of 100 miles traverses shallow lakes, some of which were dry. The deepest cutting is about midway of the canal, and is 80 feet deep. The original dimensions were: bottom width, 72 feet, 26¼ feet deep; side slopes, 2½ and 2 to 1; width at top of these slopes, which stopped about 5 feet below low-water, was about 170 feet; above those slopes were berms with much flatter slopes, so that at the water-level the width was about 250 feet.

The material excavated was principally silt, sand, and some clay, with occasionally thin strata of limestone and gypsum and some sandstone rock. The total amount excavated was about 98,000,000 cubic yards. After the dismissal of the fellaheen, dredgers were built. At the end of 1866 there were 18 small ones and 58 large ones, 20 of which were provided with long shoots to discharge the materials ashore. They were mostly bucket-dredgers, with some hydraulic ones. There were 37 hopper-barges which could go to sea, and 72 smaller ones. About one half the total prism was excavated by the fellaheen and one half by machinery.

At Port Said, to preserve the outlet channel from silting up, and to protect it from waves, a harbor of 540 acres was formed by two breakwaters, respectively 9,800 and 6,233 feet long, converging to an opening of 2,300 feet. Stone being very scarce the breakwaters were built of concrete blocks. The outlet channel must be kept open, partly by dredging, on account of the drift of sand along the coast. At Suez the outlet is well protected in a land-locked bay of the Red Sea. It is, however, guided into deep water by an earthwork embankment on one side 2,900 feet long.

The increasing size, and particularly the increasing draft, of steamships has made enlargements necessary.

Up to 1897 the depth had been carried throughout the entire length to 28 feet below mean level of high tides, with a bottom width of 123 feet. There are no curves of less than 6,240 feet radius. There are sidings for vessels meeting each other, spaced about every five miles; they are 3,280 feet long, but the enlarged width makes of the whole canal one continuous siding where vessels can pass each other at all points. To accommodate vessels of great width, two special

sidings have been made. The depth of water at Port Said harbor is 29½ feet. The longer breakwater has been extended, and is now over 10,000 feet in length. Up to 1889 the maximum draft allowed was 24 feet 7 inches; in 1890, 25 feet 7 inches.

The maximum dimensions of the canal, according to the plan of the International Commission, are to be 29½ feet depth throughout—214 to 272 feet bottom width, with 340 to 462 feet at water-level.

The total amount dredged in 1897 was, in the canal, 921,417 cubic meters, and in Port Said 593,377 cubic meters; in the enlargement, 690,694 cubic meters.

The canal is lighted electrically, either by lights on posts or on the bows of vessels, and it is traversed by night as well as by day. Its original cost was about $99,000,000, up to the end of 1878, of which $7,000,000 was expended in the previous nine years, the canal not having been fully completed at the time of opening in 1869. The total estimated cost of enlargement now under way and as above described is about $40,000,000.

The average duration of transit in 1883 was 48½ hours; in 1887, 34 hours; 1888, 30¾ hours; 1889, 26¾ hours; 1894, 19 hours 18 minutes; 1897, 15 hours 36 minutes.

The traffic-tables give the following information:

Net tonnage in 1870, 436,609; 1880, 3,057,421; 1890, 6,890,094; 1897, 7,899,373. Receipts in francs, respectively, 4,345,755.42, 36,492,620.25, 65,427,239.22, 70,918,410.43. The general increase by periods is: 1870-80, a progression of 1 to 6; 1870-90, 1 to 14¾; 1870-97, 1 to 16¾. Number of passengers: 1870, 26,758; 1880, 101,551; 1890, 161,253; 1897, 191,215. The military and naval conditions of the world largely modify this passenger movement. Passenger-receipts, in francs: 1870, 263,552; 1880, 2,015,517; 1890, 1,613,538; 1897, 1,912,150. The rates are, per ton of vessel, 9 francs; per passenger, 10 francs. The total receipts from all sources in 1897 were 75,607,029.40 francs; the total number of ships passing through, 2,986. The total expenses, including interest, etc., were 24,082,204.24 francs.

The capital of the company is 200,000,000 francs, divided into 400,000 shares of 500 francs each. The annual interest on these shares is 5 per cent. The dividends per share, after paying all interests and setting aside the required amounts for a sinking fund, amounted to 97.62 francs in 1897. From the receipts of the first half of 1898, the dividend for that year will be 100 francs, or 20 per cent.

While the periodic increase of traffic is quite regular, in the last

few years, since 1891, which was the year of largest traffic, the canal has felt the industrial, commercial, and financial depression of the world, and certain other causes have conspired to reduce the traffic, particularly during 1897. Indian wheat to England fell off from 447,000 tons in 1895 to 107,000 tons in 1896, and to 29,000 tons in 1897. There was also a loss in rice transportation, and coal to India from English ports fell off from 1,297,000 tons in 1895 to 590,000 tons in 1897. Generally the maritime movement between European ports and India fell off from 4,482,000 tons in 1895 to 3,687,800 tons in 1897.

The tide of a more general prosperity, which began about the first of the present year, makes itself felt in the movement through this canal, the receipts of which from January 1 to May 24 show an increase over the same period of 1897 of 4,860,000 francs.

NORTH SEA OR AMSTERDAM CANAL.

The first proposition to cut through the narrow strip of land separating the Zuyder Zee from the North Sea was made in 1629.

Increasing maritime business required execution of the work to obtain a short deep-water access for the important city of Amsterdam. Several projects were brought forward between 1852 and 1863. In the latter year a concession was granted, and in 1865 the Amsterdam Ship-Canal Company proceeded to build the canal. Hitherto the North Holland Canal, 50 miles long, circuitous and inadequate, had been the only means of access from the sea. The new, larger, and practically straight canal is only 16 miles long. The strip of high land cut through is 3¾ miles in width. The original section was: bottom width, 88.73 feet; depth, 23 feet; slopes, 2 to 1, with a small berm at water-level through the sand-hills and a much wider berm below water-level in the lakes traversed. The width in the former case at water-level was 176 feet; in the latter case, 360 feet. The maximum depth of cutting was 25 feet, the sides near the water-level being protected by hills with planking and bricks behind. The canal is crossed by one road swing-bridge and two railway swing-bridges. The work was finished in 1876.

It was necessary to shut off the Zuyder Zee from the canal by an embankment 4,462 feet long, in which were placed locks for that traffic. There are three locks, the largest being 315 feet long and 59 feet wide. It was also necessary to install a powerful pumping-plant at this embankment, to pump the drainage-water out of the canal, sometimes requiring 5,000,000 to 6,000,000 cubic yards in twenty-four hours.

At the North Sea end, at Yunidon, two tidal locks had to be built; they were 393 x 59 feet and 229 x 39½ feet, with 23½ feet over the sill of the larger one and 14 feet over that of the smaller one.

Increase in size of ships recently required a much larger lock to be built, which was completed in 1895. It is 740 feet long, 82 feet wide, and 30 1-3 feet deep over the sills. It was also necessary to build very expensive and difficult harbor-works to protect the entrance to the canal on this sandy and stormy coast. There are two converging jetties, each about one mile in length, built of concrete blocks placed upon a foundation of basalt rock and capped with concrete in mass. There was also placed outside, as a wave-breaker, a line of concrete blocks. The breakwaters are 3,940 feet apart at the shore, and converge to leave an opening of 853 feet between the pier-heads. The available width for navigation is 656 feet. The area inclosed is 247 acres, through which a channel was dredged to deep water, the bottom width of which was 490 and 28½ feet deep. Maintenance of this channel inside and outside the entrance requires the removal of about 650,000 cubic yards per annum, which is done with sand-pump dredgers.

Soon after the completion of the work, it was seen that the depth which was considered sufficient in 1865 was quite insufficient for the larger ships that the times were bringing out, and the depth was increased between 1877 and 1883 from 23 feet to 25¼ feet, with a greater bottom width.

In 1889 another enlargement was begun, which is now nearly finished. The final(?) enlargement will have generally the dimensions of 29½ feet depth; bottom width, 82 feet; with sidings for passing vessels. The still greater section is, however, even now proposed by the commercial interests of Amsterdam, namely, 32.103 feet deep, and 164 feet wide at the bottom.

The canal was ceded to the state in 1882, the expenses up to that date being $24,770,000. The original work cost about $15,000,000 and the removal of 21,000,000 cubic yards of earth. Traffic has steadily increased from the beginning, it being five times as great in 1892 as in 1877. In 1892 it was about 3,600,000; in 1897 it was about 5,000,000.

There are no tolls upon the canal, it being owned by the state.

CORINTH CANAL.

The project for a canal at Corinth dates back to the year 600 B. C. Three hundred years afterward the Athenians hauled their triremes, of 150 tons, over this isthmus on a stone ship-railway.

In the reign of Nero trial-pits were sunk in places across the narrow part of the isthmus and work was actually begun, traces of which were found when the surveys for the modern work were made, the pits being used to determine the character of the strata to be encountered. The modern work was begun in 1882.

Had the canal, even on a smaller scale, been built when Athens was the center of the civilized world, or even in the time of the Roman emperors, the shortening of the journey between Rome and Athens would have been very advantageous, but it could not be expected that a maritime canal between countries that had almost gone into decay would result in great benefit.

The distance to be saved between Adriatic and Black Sea ports is 212 miles; between western Mediterranean and Black Sea ports, 110 miles. In 1881 the Hungarian, General Turr, obtained a concession for building the canal, and work commenced in 1882.

The width of the isthmus is a little less than four miles, with deep water about 200 to 300 yards from the shore of each sea. The ground rises very rapidly, so that the cutting averages 190 feet for a length of 2 3-5 miles, with a maximum cutting of 287 feet. The line of the canal is straight. The dimensions are 72 feet bottom width, 26¼ feet depth below lowest water-level, side slopes 2 to 1 to 1 to 1 in soft soil and 1 to 10 through rock.

The eventual depth proposed was 27.10 feet, but as executed the depth was 3 or 4 feet less. Harbors were built at each end, of rubble-stone. In the Gulf of Corinth there are two converging breakwaters, 1,310 feet and 1,640 feet long, starting from shore 1,150 feet apart, and leaving an entrance 262 feet wide. In the Gulf of Ægina a single breakwater was built. Only one bridge crosses the canal, 242 feet span, 141 feet in the clear above the water, carrying a railway and roadway. The canal company must maintain a free ferry-service at each end of the canal. The old Nero test-pits gave no information about the material lying below their level, and bad sliding material developed, requiring the slopes to be flattened in rock to 1 in 5, and even 2 in 3. It was found necessary also to line the slopes with 216,000 cubic yards of masonry, from the bottom of the canal to above the water-level, along 2 3-5 miles of the central portion, greatly increasing the cost. The total amount of the material excavated was 14,260,000 cubic yards.

In 1889 work was stopped from lack of funds. Then funds were provided by the Société du Comtoir d'Escompte of Paris. This Société failed, and payments ceased; and the canal company was thrown

into liquidation. A new company, the Société Hellenique du Canal de Corinth, completed the work in 1893.

It is difficult to ascertain the actual cost of this work. The total issue of shares was $13,750,000, but the real cost was much less.

Navigation of this canal by large vessels is hindered by its small section and steep sides. Speed is limited to seven miles per hour. The traffic since 1893 has been as follows:

	No. of vessels.	Tonnage.
1893	182	10,183
1894	2085	240,122
1895	2324	346,033
1896	2514	368,484
1897	404	329,063

The toll is about 20 cents per ton. The revenue in 1897 was $60,510, and the working-expenses were $56,275, leaving scarcely anything for interest or dividend. Loss of traffic is attributed to the Turko-Grecian war and failure to derive benefits from a tariff reduction, the Italian and Austrian maritime companies not being willing to use the canal.

The cause of the practical failure, to date, of this canal can easily be found. The advantages of shortening the route are seriously impaired by the fact that the canal is not always accessible to vessels of 23 feet draft; by the narrowness of the channel for large ships; and by the hard, steep sides, making it dangerous to navigate. Unfortunately there are no funds available for ameliorating these troublesome conditions.

KAISER WILLIAM CANAL.

This project was under consideration for several centuries, and was partially realized in 1777-78 by the construction of the Eider Canal, 26 miles long, which enabled vessels of 120 tons to pass between the Baltic and North Seas.

When Kiel became the great naval arsenal of Germany, the necessity, or at least the immense advantage, of securing a short and safe passage between the two seas entering German territory led to the construction of this work. The project was prepared in 1864, shortly after Schleswig-Holstein was separated from Denmark, but the wars of 1866 and 1870 delayed the work. Its construction was approved in 1886, work was begun in 1887, and the canal was formally opened in 1895. Its length is 61 1-3 miles; the bottom width, 72 feet, with six wider passing-places; side slopes, 3 to 1 near the bottom and 2 to 1 higher up; minimum depth, 29½ feet. There is a narrow berm below the water-level in deep cuttings, and a wider one in low ground. The width of the water-surface is 216 and 283 feet. The deepest cutting

is 108 feet, traversing there the ridges between the rivers Eider and Zehe.

This is a sea-level canal with regulating locks at each end; it has embankments on both sides in low ground, and the slope is protected by stone pitching from 6½ feet below the water to 3¼ above it. The sharpest curve has 3,300 feet radius, and at all curves the canal is widened, according to the curvature, from 3¼ feet to 52½ feet. The total quantity of material removed was 105,000,000 cubic yards. There are two fixed and two draw bridges. Locks are necessary, for while the Baltic is practically a tideless sea, the North Sea at Brunsbettel has a maximum range of 27½ feet. Two locks, side by side, allow for the passage at the same time of outgoing and incoming vessels. The lock-chambers are 492 feet long and 82 feet wide; the sills are 33 2-3 feet below the normal low-water level. Work was completed in the time specified, and slightly within the estimated cost of $40,000,000.

The canal is illuminated with electric lights, placed 800 feet apart on tangents and closer on curves. Passage-time through has been fixed at 10 to 12 hours, to prevent too great wash of the banks. The distance saved between Hamburg and Bremen and German Baltic-Sea ports is 425 and 323 nautical miles, respectively, or 45 and 32 hours. The saving to Amsterdam, Rotterdam, Antwerp, Dunkirk, and English ports is about 238 nautical miles, or 22 hours; to Scottish ports, about 100 miles and 5 hours. However, British ship-owners make little use of the canal, due particularly to the shallow, narrow, and tortuous channels of the river Elbe in approaching the canal, and from the further fact that British ships must call at Copenhagen on their trip to the Baltic Sea, and because the disadvantages and dangers of the Skagen Channel, between Denmark and the Scandinavian peninsula, have been greatly reduced by buoying and lighting the channel.

Toll-rates are generally, the first 400 tons, 15 cents per ton; each additional ton, up to 600 register tons net, 10 cents; up to 800, 7½ cents; above 800, 5 cents; with special regulations for the small German coasters and for vessels in ballast.

The traffic for 1895 amounted to 1,505,983 net tons; 1896, 2,036,-861 tons; 1897, 2,345,849 tons. Receipts for 1895-96 were $225,000; for 1896-97, $ 272,000.

The canal serves the double purpose of facilitating naval operations and shortening commercial routes over an extensive area.

MANCHESTER SHIP-CANAL.

The City of Manchester, England, is situated on the Irwell, about fifty miles from the Liverpool bar. This canal avoids cost and delay

in transshipment at Liverpool. In 1882 a plan for its construction was proposed by E. Leader Williams as engineer and James Abernethy as consulting engineer, the terminus in the estuary of the Mersey to be a point opposite Garston, and the canal in the estuary to consist of low training-walls. Several modifications were made in the route and plans of the canal during the various discussions that took place in Parliament. The final total estimate on the plan before that body in the spring of 1884 was £6,904,186 12s. 6d. The plan was opposed in Parliament by the Mersey Docks and Harbor Board, on the ground that it would reduce the depth of the Liverpool bar at the mouth of the estuary; and as this view was sustained by James B. Eads, the engineers of the ship-canal changed the route so as to reach the estuary at Eastham, about six miles from Liverpool, on the south bank of the estuary. The necessary parliamentary approval was then obtained.

Locks for admitting vessels at Eastham (three in number) are, respectively, 600 feet long by 80 feet wide, 350 feet long by 50 feet wide, and 150 feet long by 30 feet wide. Four other sets of locks between there and Manchester are of similar dimensions. The total length of the canal is 35½ miles. The total rise from the ordinary water-level of the canal at Eastham to the docks at Manchester is 60 feet 6 inches. Dividing this between the four sets of locks gives an average rise of about 15 feet 1½ inches. All the locks are worked by hydraulic power. Railways and highways crossing the route of the canal have been raised by expensive constructions, so as to give a clear height of 75 feet for vessels traversing the canal. The remaining seven main highways cross the canal on swing-bridges. There were required in all 14 bridges. An ordinary canal was carried across by a swinging aqueduct composed of a long iron caisson resting on a pivot-pier.

This canal is excavated throughout its whole length to a minimum width of 120 feet at the bottom, and it averages 172 feet wide at water-level. The upper portion, from Barton to Manchester, is 170 feet wide at the bottom and 230 feet at water-level. At the various locks the canal is widened considerably, and vessels can be turned there if necessary. The width adopted permits large steamers to pass each other at any part of the canal, whose minimum depth is 26 feet. Sills for all the locks are placed 28 feet below water-level, to allow future deepening by dredging. Extensive docks have been constructed at Manchester, and at Warrington there is one of 23 acres. The time required for navigating the whole length of the canal is from five to eight hours.

The masonry, both brick and stone, used in the locks, basins, piers,

and retaining-walls is of the best quality, both in materials and workmanship. The total amount in cubic yards of brickwork is 175,000 and 220,000 cubic yards of masonry. The lower portion of the lock and dock walls is made of concrete, the culverts being lined with masonry of brickwork. At the water-level, granite or limestone fender-courses, slightly projecting from the face of the wall, are inserted to protect the concrete facing. The deepest cutting is near Runcorn, where, for a short distance, it is 60 feet. The cutting with the largest prism is at Latchford, where, for a distance of 1½ miles, the depth averages 55 feet. The slopes of the excavations vary with the nature of the soil from 1 to 1 to 2 to 1. In the lock-excavations the sides are nearly vertical. The total amount of excavation in the canal and docks was about 53,000,000 cubic yards, 2,000,000 cubic yards of which was in sandstone rock. All of this waste material from the canal was used in filling up the bends of the river Mersey, which are cut off by the canal, and in raising the low lands so as to make them available for shipping, building, and other purposes. The canal was opened for operation throughout on January 1, 1894. The total cost was about $75,000,000. The excess over the estimated cost ($46,000,000) was largely due to the extraordinary cost of right of way.

Traffic has increased as follows: 1894, 925,659 tons; 1895, 1,358,835 tons; 1896, 1,826,237 tons; 1897, 2,066,000 tons. The total revenue in 1896 was about $900,000.

In the first half of 1897, after meeting all expenses and making improvements, the company had sufficient surplus to pay $183,715 interest on the first debentures and $44,325 on the second. The capital is: $20,000,000 ordinary shares, $20,000,000 preference shares, and $37,000,000 in four classes of debentures.

Facilities are not adequate to the rapidly increasing business. Grain-elevators are being erected. A large estate is being transferred into industrial plants, and commercial facilities and lines of steamers established to several points, Canada and elsewhere.

As to cost, competition, and opposition, every possible objection was thrown in the way of the work by vested interests that might suffer from the competition of the canal, especially the railways and the port of Liverpool. The former took occasion to demand the most expensive constructions in the elevation of their tracks, and when the canal was built entered into a ruinous cutting of rates from Liverpool to Manchester. Again, the towns and property-owners along the route of the canal insisted upon many constructions that have since

been found to be unnecessary, but the canal company can now look forward to increasing prosperity, and to a fair return on the investments.

There are other canals that might be described, but they hardly come under the head of ship-canals, as—

(a) Their draft is limited, or

(b) Their purposes are not strictly commercial, or

(c) They are simply channels deepened by governments or cities to connect bodies of water or to reach ports. For example:

The Caledonian Canal, in the North of Scotland, with a draft of 15 feet. The North Holland Canal, with a draft of 18 feet. The Chicago Drainage Canal, connecting Lake Michigan with the Illinois and Mississippi Rivers, with a draft of 22 feet when completed; this really forming an interior harbor for the port of Chicago and to afford a sewer. The Welland Canal in Canada, between Lakes Erie and Ontario, 26¾ miles long, and 14 feet deep. The Ghent-Terneuzen Canal, 19 feet deep and 20 7-10 miles long, from Ghent to the Schildt. The St. Clair Flats Canal, between Lakes Huron and Erie, with a depth of 22 feet. The St. Mary's Canal, now being deepened to 21 feet, between Lake Superior and Lake Michigan. The St. Petersburg and Cronstadt Canal, 17½ miles long, 22 feet deep.

Canals under construction or projected are:

(1) The Bruges Canal, now nearing completion. It is to be 7½ miles long, 26¼ feet deep, and will cost, including port-works at Heyst, on the seacoast, and at Bruges, $7,800,000.

(2) The Brussels Canal, to connect the Scheldt with Brussels and to make a maritime port of that city. This canal will be 16 miles long and 19 2-3 feet deep, so that vessels of 2,000 tons may reach Brussels. Its estimated cost is $7,000,000.

(3) The Berlin Ship Canal, to convert Berlin into a seaport, with a depth of 25 feet and average cost of $50,000,000.

(4) The Baltic-Black Sea Canal, 1,000 miles long, 28 feet deep; cost estimated at $25,000,000; very doubtful; and the Canal of Two Seas, Bordeaux to Cette.

(5) The Massachusetts Maritime Canal (Cape Cod), connecting the waters of Long Island Sound and adjacent waters with Massachusetts Bay; length, 7¾ miles; estimated cost, $5,000,000.

There are also the much-discussed interoceanic canals, the Panama and the Nicaragua, the present uncertain status of which as to plans and cost is so indefinite as to make it unprofitable to describe them.

By comparing the foregoing general facts concerning the great

ship canals of the world which have already been constructed, it is possible to draw some conclusions which may enable the proposed American isthmian canal to be judged upon a broad economic basis.

It has been shown that nearly all the existing canals met with opposition in their inception, and with meagre financial returns when first operated, yet who can doubt that they have been for the general good of nations and commerce? It is with great engineering works as with great political events, the very nearness prevents a true estimate of importance, and it is only when sufficient time has elapsed that the real value of any great project can be correctly determined.

Thus it was with the early history of internal waterways, with railways, and with nearly all the ship canals which have yet been constructed; and so it will doubtless continue to be with any isthmian canal, whatever route may be selected. It is only when considered in the broad light of its ultimate effect upon the welfare of mankind and the commerce of the world that a true conception of the importance of the waterway through the American isthmus can be grasped.

EDITORIAL COMMENT

One of the interesting features appearing in a monthly examination of such a collection of data of current engineering matter as is contained in the Engineering Index is the advent of notes relating to new subjects, followed by the rapid rise of interest, the influx of competing ideas, and frequently their descent and disappearance after having been a nine days' wonder. In some cases the Index contains the history, including the origin and growth of discoveries which have become classical, such for instance as the subject of radiography, from the first brief announcement of Dr. Röntgen's discovery, through the horde of followers and imitators, down to the present systematic use of the method. A subject furnishing a single note in one issue of the Index, is the source of many references by the next issue, and so the student can observe the pulsations along all the lines of engineering work by a monthly perusal of the pages of the Index. An excellent example of this is seen in the brief note of Dr. Wehnelt's electric interrupter in the April Index, followed by a number of articles on the same subject in the May issue; and a similar growth of interest appears in the notes about the Nernst lamp, as they gather from month to month.

* * *

The principal feature in mechanical engineering is the continued interest in the applications of electric driving to machine tools. Instead of questioning the feasibility of the introduction of electric driving into the machine works, the question is now rather: "On how small a machine does it pay to put an independent motor?" Not only in the machine shop, but on shipboard, on the farm, in the mine, and in fact, everywhere where power in subdivided form is required, the advantages of electric driving are beginning to be realised.

Another subject of importance to the works manager is the investigation of the various systems for compensating labour, including piece-work, the premium system, and similar methods, together with the always present problem of cost-keeping and its allied details of factory accounting.

In view of the progress which has been made in the study of the physical constitution of materials of construction, and the influence which structural changes have upon physical properties of metals, especial interest attaches to the investigations of the properties of various metallic alloys. There is little doubt that the hitherto mysterious failures of materials supposed to be amply strong to resist the stresses to which they were subjected, might have been fully explained had metallurgists been possessed of the modern means of investigating the causes of weakness as exhibited in internal structure. Nearly every month the fruit of additional research in this field of metallurgy is placed upon record, and new methods of inspection and verification of properties follow.

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One of the principal features of mining engineering, noted more fully elsewhere, is the gradual transformation of the mining of the precious metals from a gambling hazard into a methodical branch of manufacture. A gold mining claim is now surveyed, prospected, either by shafts or by drills, dredged by improved modern machinery, and fully exploited in the same business fashion as if it were a bed of iron ore, and the resulting product is known to represent the entire value which it is commercially profitable to obtain. Capital is supplied by investing shareholders, miners are employed in the same manner as labour in other industrial enterprises, and the glamour which formerly surrounded the winning of the yellow metal is obscured in a cloud of factory smoke.

The utilisation of natural sources of hydraulic power goes steadily forward, and the latest transmission in Southern California, utilises more than 700 feet head of water to generate 4,000 horse-power, transmitting it electrically at a pressure of 33,000 volts to Los Angeles, eighty miles dis-

tant from the power station in the mountains. Other installations in Utah, and elsewhere in the United States are included in the power plants indexed this month, and new projects in Switzerland, the Tyrol, and Italy, indicate Europe is not behindhand in appreciating the value of natural power, electrically transmitted and utilised.

* * *

The international subject of ship canals is gradually attaining its true position in the public mind, and it is beginning to be seen that works of such magnitude must necessarily be of slow growth, and cannot be promoted and exploited in a manner similar to ordinary business enterprises. Viewed in the ordinary light of an investment operated for the sole purpose of returning immediate dividends upon the shares representing the capital used in the construction, the ship canal can in many cases be demonstrated to be a most unprofitable sort of a hole in which to bury good money. Considered in the far broader view of its effect upon the development of civilisation, it is beginning to be realised that the profit of such enterprises cannot be measured by a direct money value, dealt out in the form of interest or dividends, but must appear in the deeper, slower, but far more powerful influence upon the business of future years.

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For a number of years there has been developing a general tendency in engineering educational institutions to consider original investigation as much a portion of their work as the mere routine of teaching, and at the present time the mechanical and physical laboratories of such institutions are in many cases the best equipped places for technical research which can be found. A noteworthy addition to this branch of engineering work is found in the new hydraulic laboratory at Cornell University, at Ithaca, N. Y., where advantage has been taken of a natural supply and head of water to construct a hydraulic laboratory rendering it possible to investigate many problems in connection with the generation of hydraulic power with quantitative accuracy and precision. The elusive subject of the flow of water may here be studied more thoroughly than ever before, and the converse problem of the resistance of water to the motion of immersed solids can also be investigated.

* * *

Various papers upon the ventilation and warming of buildings, for large audiences, classes of pupils and individual families, contain much valuable matter. It is beginning to be appreciated that healthful warming includes the maintenance of the normal degree of atmospheric humidity, and that much of the excessive heating with dry air, so prevalent in the United States in winter, may be satisfactorily replaced by air of a lower temperature but higher degree of humidity, with manifest improvement both in healthfulness and comfort.

* * *

The development of the automobile, accompanied with the increasing use of asphalt paving, is leading to serious discussion of the possibility of maintaining clean streets in great cities by preventing the accumulation of dirt rather than by removing it after it has been permitted to collect. By far the larger part of the dirt which fouls the streets of a city, creating a frequent nuisance, and impairing the health of the residents, is due to the presence of the horse. It might be an interesting experiment to forbid all horses for a given time upon certain asphalted streets, permitting only automobiles and bicycles, in order to observe the length of time which might safely be permitted to elapse before cleaning. It is not at all improbable that the time may come when horses and other animals will be forbidden in the streets as rigidly as they are now barred from public and private gardens; all the transportation in cities being accomplished mechanically and the horse being relegated to the country, to the great advantage of both man and beast. The clean city could doubtless thus be secured, not by cleaning it, but by preventing it from ever becoming dirty.

* * *

The transformation in methods and tools in the modern machine works, brief reference to which was made in these columns last month, is a matter which cannot be studied too closely by such works managers as are desirous of keeping fully in touch with the signs of the times within their own especial province. The present

state of the machine trade in England is not unlike that of the skilled calligraphist at the time of the invention of printing. He was capable of executing the most beautiful and successful work, and he was very busy. He had heard, in a more or less indirect manner, that certain improved devices had been made which, when once prepared would produce many books in the time required by him to pen a few pages; moreover that these machine-made books would all be exactly alike, and were beautifully made at small cost. At first he did not believe these tales; then, when compelled to admit their truth, he said that such crude methods could not interfere with him, for he had more work than he could accomplish in a lifetime, and his work was not to be compared with that of such unskilled creatures as were employed upon the base art of mechanical printing. Even while he thus attempted to hold his position against the advancing tide of progress he was swept off his feet, and carried away in the flood which he could not stem, and the transformation was wrought.

It is exactly a parallel transformation which is being carried on before our eyes. Identical multiplication of innumerable articles produced by machines of marvelous perfection, adjusted and cared for by experts, but operated by ordinary tenders, is destined to replace the process of the passing system in the immediate future. And the influence of the modern machine tool upon civilisation, upon the future of society, will be no less profound than has been that of the bits of lead and the sheets of paper set in motion by the printer of Mayence, more than four hundred and fifty years ago.

* * *

The law of demand and supply, or rather of demand and supplies, holds as good in engineering matters as it does in the commercial world, and again this is being demonstrated in connection with the rise in the price of copper. It will be remembered that when, in 1888, the Secretan syndicate attempted to corner the copper market, and did succeed in forcing the price up to an abnormal figure, one of the causes which led to the collapse of the scheme was the use of substitutes for copper wherever possible. It was found, that so far from the consumption being a fixed or increasing quantity, it became contracted far below what had been thought the lowest possible minimum, and the prolongation of the struggle thus maintained, broke the endurance of the combination.

The price of copper has been forced up again, and at the present time it has reached a point where it affects most seriously the cost of conductors for electrical transmission systems. Fortunately there is a strong competitor in the field, and at the present price of copper, aluminum is found to be an effective and economical substitute. About a year ago, Mr. A. E. Hunt showed that when the price of copper reached about one-half that of aluminum, their commercial values as electrical conductors were equal, and at the present time this fact is causing many engineers to turn to aluminum as a means of escaping the prohibitory cost of copper. Already aluminum conductors are used to advantage at Niagara, and there is no good reason why such a noteworthy example should not be followed elsewhere. Again the engineer may frustrate the schemes of the speculator, and in so doing he will undoubtedly be fulfilling once more the true function of the engineer in directing the forces of nature for the use and convenience of man, to the discomfiture of those who would repress them for his disuse and inconvenience.

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There has been much foolish talk in some of the papers in the United States about the wonderful possibilities of liquid air as a source of "costless power," this having been started by a statement in a popular magazine that with ten gallons of liquid air, three gallons could be used to make ten more gallons, and so on indefinitely, and some persons really seem to have taken the statement seriously. At a recent meeting of the American Society of Mechanical Engineers, after some striking experiments with liquid air, Mr. Charles E. Tripler, who has manufactured liquefied air on a large scale, endeavored to explain this seeming paradox, and while his language to most of his hearers seemed to re-emphasise the original fallacy, yet it was evident that he meant to say that it took about three gallons of liquid air to

do the cooling for the production of ten more gallons, the balance of the work being performed by the energy of the compressor. It is one of the unfortunate results which often follows the treatment of scientific subjects by popular publications, that neither contributor nor editor is qualified to detect such errors at first glance, and it is not until an unpleasant notoriety has been attained that they become aware of the facts.

In another portion of this issue will be found a conservative and thoughtful view of the possibilities of liquid air, written for THE ENGINEERING MAGAZINE by one of the foremost scientists of America, Professor Elihu Thomson, and it is believed that his presentation of this important and interesting subject will contribute materially to disseminate a correct view of the probable applications of this valuable addition to the resources of the engineer.

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The wide-spread interest in M. Marconi's success in telegraphing over considerable distances without communicating wires is a striking example of the way in which our estimate of the marvelous is influenced by the previous viewpoint. The fact that sound and light waves have been known to be propagated without the absolute necessity of any solid conductor is so familiar that no one considers it at all wonderful that we can hear without the necessity of a tube communicating with the source of sound, or see without an instrument between the eye and the object; but the moment it is announced that electric waves may also be originated, transmitted and received through the ether without other material connection, we all rise up and say "how wonderful!" It is indeed wonderful, even as the transmission of sound or of light is wonderful, but to the popular mind it is mainly wonderful because it has not yet had time to become familiar.

As to the possible applications of space telegraphy, these may be limited by conditions similar to those limiting the use of transmission by sound or light. As a powerful noise may drown out an oral communication, so a powerful emission of disturbing electric waves may prevent wave telegraphy from being intelligible, while the desire for privacy can hardly be assured in the present state of the art, at least. It is too early, however, for the limitations of the method yet to be defined, and in view of what has been accomplished we can only speak of the immediate results.

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From time to time various criticisms have appeared, either from practicing engineers, or from trustees and managers of educational institutions, concerning the entrance of professors into the field of consulting practice. The charge is distinctly made that the professor who permits himself to undertake to express his opinion upon an engineering work for a fee, is in some occult manner injuring his pupils, his fellow engineers, the institution by which he is employed, and, last but not least, himself.

It is perfectly possible to perceive how, in some instances, this view of the case may be entirely well founded, for professors are not unlike other men, and will, upon occasion, neglect their duty, but such cases should stand on their merits, or rather on their defects, and not be made a cause of condemnation of the great majority of instances in which the reverse is true. One of the greatest defects of technical schools, otherwise excellent, lies in the absence of close touch of the professors with contemporary, active practice, and the students enter upon their work after completing their courses only to find that they have been taught by a lecture room instructor, himself the successor of a similar unpractical teacher, with much to learn and more to unlearn.

Those who observe this matter from an impartial standpoint, cannot fail to note the live, active methods of the professor who not only enters into the external practice of his profession, but takes his students into it with him as assistants; and there is no better training possible for the pupil than thus to be initiated into the real field of work which he is afterwards to occupy. The man who, in such practice would neglect his true duties towards his pupils and his institution, is obviously unfit to hold a position of trust and responsibility in any case, while a professor who can command the conduct of responsible professional work should be considered doubly desirable as an instructor.

REVIEW OF THE BRITISH PRESS

Safety Mining Explosives.

IN view of the increased attention which is being given to the prevention of accidents in mining, and especially to the avoidance of explosions of fire damp, the paper of Mr. Oscar Guttman, recently presented before the Society of Chemical Industry, and printed in the *Colliery Guardian*, is especially timely, treating, as it does of the principles which lie at the foundation of safety in mining explosives.

The numerous tests which have been made in England, France, Austria, and elsewhere upon the ignition of pit gas have shown that two requisites must be fulfilled in order that an explosive may ignite the gas. In the first place a high enough temperature must be produced, and in the second place the duration of the heat must be long enough. Hence ignition may be prevented either by causing the temperature to be kept down, or by increasing the rapidity of the explosion to a degree affording insufficient time for the gas to ignite.

Pit gas consists of about 95 per cent. of marsh gas, or methane, and mixtures of air containing from 6 to 10 per cent. of methane form a dangerously explosive mine air, against the ignition of which every practicable precaution should be taken. According to the tests made by the French commission, it was found that the pit-gas mixture must be heated to a temperature of 650° C. before it will ignite, and that even then the source of heat must continue to act for at least ten seconds, in order to produce inflammation. Thus it is possible that a flame acting for a short time only, such as that produced by the detonation of an explosive, may have a much higher temperature without producing ignition. Some of the experiments showed that with rapidly detonating explosives a temperature of 2,200° C. was required to produce ignition. The comparative slowness of the combustion of gunpowder renders it necessary to provide some means of preventing the heat from reaching the gas, while the high temperature of some of the rapid explosives unfits them for use in gas-laden workings.

The earlier methods of rendering blasting explosions free from danger involved the use of some form of protecting jacket. Among these may be mentioned the water cartridge, in which the explosive is surrounded by a jacket of water. This is undoubtedly safe, but is inconvenient, and requires a large borehole. Tamping with wet moss or with damp clay gives good results, while a fair degree of protection is obtained by the use of a tamping of dry sand. The very general use of explosives other than gunpowder, however, renders protection of this sort less desirable than the restriction of permitted explosives to those unable to produce ignition. The requirements in Austria are that the material should explode with a short, but not bright flame, and, when used up to a certain weight, should not ignite mixtures of firedamp and coal dust. In France the requirements are that the products of the explosion should not contain inflammable substances, and that the temperature of the explosion must be below 1,500° C. In England there is no especial definition, each explosive being required to undergo test at Woolwich before its use is permitted.

While the above requirements are in general well adapted to insure safety, there are some exceptions which should be taken into account. In general it is correct to assume that the ignition of firedamp depends directly upon the temperature of the explosion, but it has been demonstrated that, by increasing the weight of the charge, certain explosives cease to be safe, notwithstanding the fact that the temperature limit has not been exceeded. There appears to be a "breaking point" with each explosive, forming a limit of quantity which may be safely used, and it is not improbable that when this point is reached the force of the explosion acts in a manner similar to compression in a gas

engine, lowering the ignition temperature and changing the conditions to a marked degree. Extreme rapidity of explosion is also open to objection, probably for a similar cause to that existing with large charges, the force of the concussion changing the conditions, and the safest method is to use moderate charges of explosives producing temperatures low enough to be altogether incapable of igniting the gas.

Much expense has been incurred in the construction of trial galleries, and in experiments with various gas mixtures, both natural and artificial, and in the light of the results which have thus been obtained it is possible to limit the use of explosives for blasting in gaseous workings to such as by composition and action are free from material danger.

Mr. Gutman's paper gives many interesting details with testing, and discusses also the use of detonators, and of various materials for cartridges, and is altogether a valuable contribution to the literature of the subject.

The Performance of Refuse Destructors.

THE disposal of town refuse by incineration is by no means a new method, but of late there has been much discussion as to the possibility of utilising the heat evolved during the combustion to any advantage. The results obtained at Shoreditch are largely responsible for the present interest in the subject, and precise data about other installations are welcome additions to the store of practical knowledge in this important branch of sanitary engineering.

From a report recently submitted by Lord Kelvin and Professor Archibald Barr upon the working of the Horsfall destructors at Edinburgh, Bradford, and Oldham, some valuable information may be obtained, the report being published in *The Engineer*, with tables of the results, and illustrations showing the construction of the furnaces.

While there are several fundamental principles which should be observed in the design of refuse destructors, it is always desirable that the special nature of the refuse to be disposed of in any given case be taken into account in construction of the furnaces. Although the primary object in view is always the sanitary one, it is also desirable to obtain as large a thermal efficiency as possible and it is entirely practicable to unite both features in the highest degree if proper precautions are taken. In order that all noxious and deleterious matter shall be fully and completely destroyed it is essential that a high temperature be maintained, and this requirement is also favourable to the economic utilisation of the heat produced. The high temperature is necessary not only in the furnace where the solid refuse is burned, but also in the flue through which the discharge gases are passed, in order that all gaseous hydrocarbons may be fully consumed, and neither smoke nor offensive gases discharged at the chimney top. The best combustion is attained in the furnace when the feeding door and discharge flue are so placed that the gases distilled from the raw material shall pass over the hottest part of the furnace on their way to the main flue and be brought quickly into contact with the intensely hot gases arising from the previously dried and incandescent material upon the grate bars. A forced draught is necessary to maintain a powerful combustion on the grate bars, and in the Horsfall destructor this draught is produced by steam jets. The steam, being condensed serves, by re-evaporation, to protect the grate bars, and is subsequently decomposed in passing through the bed of incandescent refuse, thus producing water gas, which is burned by the excess air over the fire, serving to increase the temperature which would otherwise exist at the meeting of the products of combustion with the gases distilled from the raw material.

The destructors are best arranged in series, all delivering into one flue, so that the brickwork in the flue is always kept very hot while the clinker is removed from the cells in rotation. When the fire in one cell is green, the other cells will be discharging hotter products, and thus the temperature of the flue will at all times be maintained sufficiently high to prevent any noxious vapors from reaching the chimney.

The utilisation of the heat produced by the incineration of the refuse is accomplished very simply by placing steam boilers in the flue in such a manner that the

intensely hot gases, already fully burned, come in intimate contact with the heating surface of the boilers. For this purpose water-tube boilers have been found very effective and a large portion of the heat is thus converted into a form available for use for power, electric lighting, or whatever may offer the best returns. The refuse at Oldham gives a steam production equivalent to the evaporation of 1⅓ pounds of water from and at 212° F. per pound of unscreened refuse treated, and it is believed by Lord Kelvin and Professor Barr, that, in a plant designed to utilise the heat to the fullest extent, an evaporation of 1½ pounds of water per pound of refuse, or even more, could be reached, and that without in any way affecting the perfection of the process from a sanitary point of view. According to these figures, the Oldham refuse has a fuel value of about one-seventh that of good steam coal. From the tables accompanying the report it appears that the Oldham refuse produces about 33 per cent. of clinker, one cell having a capacity of eight tons of refuse for every twenty-four hours. Analyses of the gases discharged at the chimney show the presence of only nitrogen, oxygen, and carbonic acid, there being no carbonic oxide nor hydrocarbons discharged.

The report contains much valuable information for designers of refuse destructors, and in view of the high reputation of the authors, it must be regarded as a valuable contribution to the science of sanitary engineering.

Steam Piping.

It has been well said that with the great advances which have been made in the construction both of steam boilers and engines there has by no means been a corresponding improvement in the connections between these two great branches of a power-plant. The truth of this statement is substantiated by the frequent failures of steam pipes, and the general trouble which is experienced with steam connections.

A paper recently presented before the Institution of Naval Architects by Mr. J. T. Milton gives a valuable and instructive discussion of this important subject, and although the matter is considered from the standpoint of the marine engineer the facts and conclusions are very generally applicable.

Taking as a basis the record of the failures of steam pipes and connections since 1882 some interesting lessons may be learned.

Very few pipes have given way because of defective thickness or of original weakness, nearly all of the trouble having arisen from conditions which might have been avoided in erection and use, or else from the influence of changes due to high temperature, expansion and contraction, or some similar force. In fourteen out of sixty-eight cases the accidents occurred through the absence of any provision for draining away condensed water from the pipes; while in no fewer than thirty-eight, or more than half the total number of accidents, there was insufficient provision for expansion and contraction, and for the motion due to vibration, and in but few cases did explosions occur through original defective workmanship or through subsequently developed defects.

Formerly the main steam pipes of vessels, as well as the smaller pipes, were made of copper, with brazed seams, but of late the difficulty of securing brazing which would stand the corrosive action of fatty acids under the influence of the high temperatures accompanying modern high steam pressures, has led to the adoption of seamless drawn tubing, which can be bent into the desired curves.

The original use of copper was doubtless due to its supposed resistance to corrosion, and its ductility, by which it was possible to make connections in almost any direction after the machinery was in place, without careful preliminary fitting. An element of uncertainty in connection with the use of copper piping lies in the effect which hardening has upon the extension and apparent strength, and all tests of material for this purpose should be made only after careful annealing. The diminution in strength which copper shows at the high temperatures of steam now in general use, is also a serious objection to this material, and it is a common precaution to reinforce copper pipes by wrapping them with steel or copper wire, or by fitting wrought-iron bands at short

distances apart throughout the whole length.

Modern practice, however, discards copper for main steam piping, using instead lap-welded iron or steel, the connections being made by flanges either welded or screwed on. When wrought iron or steel pipes are used the designs are generally made so that individual pipes are straight, or nearly so: although if necessary, bends of reasonable radius can be made. It is generally possible, however, to lay out the connections so that straight pipes will serve, and with proper supports, and well-made expansion joints, the pipes may be relieved of all stresses except those due to the pressure within.

Hydraulic tests of such pipes show that the bursting strength is far above the working pressure, and hence the principal care should be proper provision against external and unnecessary forces. This involves the important matter of the methods of supporting long lengths of pipes. The supports should be so arranged that while holding the pipe to its proper place and preventing vibration they will not of themselves prevent the movements due to expansion and to that of the boilers. Expansion joints should be firmly fixed and supported in position, so that the motion due to expansion and contraction will be made by the pipe, and taken up entirely by sliding in and out of the packed stuffing-box.

With carefully planned piping of steel, judiciously supported, and with ample provision for meeting expansion stresses, there is no reason why the connections between boiler and engine should give more trouble, or be a greater source of danger, than any other part of the machinery.

Telegraphy Across Space.

THERE has been much talk of late about the experiments in telegraphing across distances of many miles without the use of conducting wires, and the experiments of Marconi, both in Italy and in England have attracted much interest.

In a paper recently presented before the Institution of Electrical Engineers, M. Marconi has stated his position and work very fully, and some extracts and comments may be of interest. In the first place, M. Marconi frankly states that the theory of the method used by him is that due to Hertz, and that the coherer by means of which the reception of messages is made possible, is due to the discoveries of Questi, Branly, and Lodge, and only claims for himself the perfection of the details which have made the transmission of telegraphic messages over distances of twenty to thirty miles without wires a practical success.

After explaining the constructive details if his apparatus, M. Marconi called attention to the especial details which have enabled the distance gradually to be increased between the transmitters. The most important feature is that of the elevation of the apparatus above the surface of the earth. With the increase in elevation an increased range was invariably obtained, and the experiments seem to indicate that the distance at which signals can be transmitted varies approximately with the square of the distance of the capacities from the earth. Other things being equal, a vertical wire 20 feet long at the transmitter is sufficient for communicating one mile, 40 feet at each end for four miles and 80 feet for 16 miles, and so on. M. Marconi has made experiments both with and without reflectors, with the idea of controlling the direction of the waves, and preventing them from reaching receivers for which the signals were not intended, and although he has obtained some success with the reflecting apparatus it has only been over comparatively short distances, under two miles; all the long-distance work having been done without reflectors.

While it is too soon to predict the extent to which space telegraphy will find application, some of the experiments of Marconi have fully demonstrated its use for communicating between vessels and the shore, and it is probable that the general adoption of the apparatus upon all vessels would do much to prevent collisions in time of fog.

The Wastefulness of Steam Auxiliaries.

EVER since the experiments made upon the steam consumption of the auxiliary machinery of the United States cruiser Minneapolis there has been more or less discussion as to the best methods of securing higher economy in the important depart-

ment. The paper presented by Sir John Durston at the recent meeting of the Institution of Naval Architects upon the trials of H. M. S. Argonaut furnishes additional information upon the high steam consumption of the auxiliary machinery, fully confirming the results obtained by Mr. White in the case of the Minneapolis.

The Argonaut was especially fitted up for her trials with apparatus for determining the water consumption of the engines, special measuring tanks being provided for this purpose, and although no especial appliances were used for the auxiliaries, the relative proportion of steam used by the auxiliary machinery as a whole was determined in a satisfactory manner. All the condensed steam delivered from the main condensers was measured in one set of tanks, while that from the separate condenser used for the auxiliaries was measured independently, the percentage of steam consumption of the auxiliary machinery being thus accurately determined under various conditions.

As might be expected, the proportional consumption of steam due to the auxiliaries was much greater when the main engines were running at reduced power than when the full power was exerted, the auxiliary machinery taking nearly as much steam at one time as at another. Thus when the main engines were operated at 3,600 indicated horse-power, the auxiliaries required about 22 per cent. of the consumption of the main engine, while when the full capacity of 13,500 horse-power was developed, the auxiliaries required only 10.4 per cent. of the main engine consumption. This is an especially important matter, as it shows what a close relation the auxiliary machinery bears to the coal consumption at low powers. Much attention has been given to various means for attaining high fuel economy when cruising at low power, while at the same time this conspicuous source of loss has been neglected.

It is expected that light will be thrown upon this important subject in connection with the trials of the Amphitrite, as especial experiments are to be made with a view of securing the advantages of triple-expansion in the working of the auxiliary machinery.

As described in *Engineering*, various plans have been made to obtain a higher economy in the auxiliary machinery. The heavy duty required of the feed pumps demands a high pressure through nearly the full stroke, and results in a correspondingly high terminal pressure, and instead of delivering this exhaust steam directly to the condenser it is proposed to use it in the centrifugal pumps, the exhaust from the feed pumps being discharged into a receiver from which the engines of the centrifugal pumps are fed. After the steam has passed the centrifugal pumps it will be delivered to the distiller, and the exhaust steam from the other auxiliaries will also be discharged into the distiller, in which no live steam from the boilers is to be used.

While the economies to be effected by improvements in steam auxiliaries are undoubtedly great, there is some question as to the use of steam machinery for this purpose at all. The advantages of electric driving in subdivision of power have been so fully demonstrated in stationary plants that it seems desirable to consider the general use of electricity on shipboard for all such purposes. A single economical electric-power plant could be operated to far greater advantage than the numerous small engines now employed for auxiliary purposes, and instead of endeavouring to improve the present method it has been seriously suggested to replace all the steam auxiliaries with electric motors, leaving only the main propelling engines and the electric generating plant to be operated by steam. Whether this solution of the problem will meet all the requirements remains to be seen, but it is an experiment which may be tried before very long.

Modern Machine Tools.

An interesting paper presented before the Glasgow Association of Students of the Institution of Civil Engineers by Mr. Joseph Shepherd upon modern machine tools, led to a still more interesting discussion, since it brought some of the conditions under which modern tools, be they English, German, or American, must be operated if full value and product is to be obtained from them.

Mr. Shepherd began by comparing the activity existing in other countries in re-

spect of replacing antiquated equipment with modern automatic machinery, affirming most distinctly that if England did not awake from the stagnation existing at present, a period would soon arise when she would be in great danger of being squeezed out of the world's mechanical trade. Speaking as a tool user, and not as a tool-maker he selected from among many others, the turret lathe, and emphasised the importance of remembering that no judgment on the part of the operator was necessary, all the tools being set in the correct relative position needing no change or attention except for grinding. In such machines no measurement of work is necessary, the operations being purely mechanical, and requiring little or no skilled attention.

Reference was also made to the wholly automatic screw machines and to the heavier chucking machines, and the speaker then proceeded to show how the full advantage of such machines could only be obtained by a proper systematisation of products, so that pieces would be made in lots of not fewer than 50 to 100 at a time, while the labouring force should also be divided into the unskilled operators, caring each for a number of machines, and into skilled mechanics in a tool room, with the sole duty of the manufacture, care and storage of tools.

The discussion of the paper emphasised some of Mr. Shepherd's points very forcibly, it being shown that in order to utilise such machines efficiently it would practically be necessary to reorganise the workshops entirely. That this has not been done before is due to a variety of causes. It is the too common practice of the majority of users of mechanical products to insist on variations and modifications of these products to suit their own views. This prevents the manufacture of products in sufficient quantity to permit such duplication as alone can render automatic machinery valuable. The variety of products made in many works interferes with successful duplicate work, while until very recently the opposition of workmen to the employment of unskilled labour to produce articles formerly made only by skilled mechanics did much to prevent the introduction of modern tools.

Many establishments, also, have been too busy and successful under the old system to desire a change. Wealth of work and want of foresight have lulled the producer into the desire of taking as much as he possibly can out of his shop in the shape of present profits, in preference to an investment in new appliances and a deferment of profits. In the light of present experience, and still more in view of rapidly approaching competition, this cannot but appear as a blind consumption of capital, since the supposed profits have really been made at the expense of a depreciation of plant which has absorbed principal far more rapidly than the owners imagined.

There is little doubt that this whole question of modern machine tools is bound up very closely with the broader subjects of works organisation and the subdivision of labour, and with these comes also the necessity of considering the importance of specialisation in products, enabling skill and attention to be concentrated upon a limited variety of duplicate work and permitting the time cost to be enormously reduced while the quality of the product is at the same time greatly improved.

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The Failure of Propeller Shafts.

During the past year there has been an increasing number of failures of the shafts of screw propeller engines, and in consequence numerous discussions have followed as to the causes and remedies for such a serious state of affairs. Two papers, recently presented before the North-east Coast Institution of Engineers and Shipbuilders, by Messrs. Frank Caws and E. C. Chaston, cast much light upon the causes for the increase in shaft failures and point out some of the possible remedies.

There are two causes for shaft breakages, excessive stresses and defective workmanship, and in the papers referred to Mr. Caws treats mainly of the nature and causes of the severe stresses which propeller shafts are called upon to sustain, while Mr. Chaston deals almost entirely with defective methods of construction and workmanship.

Considering first the heavy duty re-

quired of screw propeller shafts, there is little doubt that this has been increased of late in the cases of the large number of leviathan tramp steamers which have been built during the past few years. These large vessels have been constructed for the reason that they are more economical, both from the increased capacity and because of the proportionally reduced amount of engine power required. The result has been the introduction of many ships of large displacement and moderate powering, conditions which, however favourable to commercial transport, approach closely to the danger line so far as the strength of the shafting is concerned.

In the first place, the accepted rules for proportioning the size of the propeller shaft make the strength of the shaft depend entirely upon the power of the engines, this being true both for the rules adopted by Lloyds and by the Board of Trade. If the vessel were to be propelled steadily through smooth water, this would undoubtedly be correct, but the stresses due to propulsion are by no means the most severe to which the shaft is subjected.

The tossing and rolling of the ship, due to the action of the waves, throw many sudden and severe stresses upon the propeller and shaft, and as these do not originate with the engines, the powering of the vessel is no measure of such stresses; they are rather measured and determined by the inertia of the ship's displacement mass. The greatly increased size of modern freighters and their proportionally lower powering emphasises this discrepancy between stress and strength, and points clearly to the fact that greater strength is necessary for propeller shafts than is indicated by the power of the engines. Long vessels are also more flexible than shorter ones, and thus another disturbing element is introduced into the computation. Of course it is impossible to avoid flexure in the hull of a vessel, and under such conditions great stiffness in the shaft would only create still more injurious stresses, for under no circumstances can the shaft be expected to stiffen the hull.

What is really needed, therefore, is not the maximum of stiffness, so much as the maximum of harmony between the flexibility of the ship and her shaft. In many cases the injurious stresses on a shaft are intensified by imperfect fitting. As Mr. Chaston points out, this is often due to the common practice of boring out the coupling bolt-holes, and fitting the coupling-bolts on the floor of the shop, instead of finally reaming the bolt-holes and fitting the bolts in the shaft when it is in position in the ship afloat, as was formerly the practice. Numerous instances are cited where shaft breakages are directly traceable to this cause, and where injurious strains upon bearings have been entirely removed by refitting the couplings.

Defective material is often thought to be a cause of shaft breakages, but as a matter of fact this is very rarely the case. The very thorough inspection to which every shaft is subjected is sufficient to detect any serious flaw which may have developed during the forging, and the supervision, both of the Lloyd's inspectors and the skilled mechanics engaged upon the work of turning and finishing, is the best protection which can be had against defective workmanship. Added to this may be mentioned the improvements which have constantly been made both in material and methods, so that it may safely be assumed that in nearly every case propeller shafts are fully as strong as their dimensions indicate, and that breakages are due to stresses which they were never proportioned to sustain.

In many cases shipbuilders have voluntarily increased the proportions of propeller shafts beyond that required by Lloyd's rule, but the exercise of such discretion can hardly be expected in all cases, and it is heartily to be desired that some more rational expression for the computation of safe proportions for such important members be determined and enforced.

The Measure of Horse-Power.

THE use of the unit horse-power for measurement of the power developed or required by any particular example is probably too firmly rooted to be disturbed to any great extent, but it is desirable for many purposes that its various synonyms be known and used. An interesting article in a recent issue of *The Engineer* deals with this subject, in a rather pleasant vein, bringing out at the same time some

features in connection with power computations which will bear repeating.

The general idea of the horse-power as consisting of a definite number of foot-pounds per minute is the fundamental conception, and there is little doubt that by far the greater number of engineers compare other rates of work with the horse-power by reducing them to foot-pounds per minute before making the comparison. As a matter of fact, the foot-pounds per minute idea is but one of many equivalent expressions, all of which are equal to the same development or expenditure of power, and it is sometimes very convenient to be able to avoid the intermediate reductions in converting the one into the other. For this reason the writer of the paper referred to gathers these equivalents, and classifies them into groups, as: Elementary; Hydraulic; Thermal; and Electrical. These are tabulated in connection with the time units of the hour, minute, and second, and a very convenient set of constants is thus obtained, expanding the familiar 33,000 foot-pounds per minute into such expressions as: 375 mile-pounds per hour; 4,500 kilogrammetres per minute; 42.42 Fahrenheit heat units per minute; or 746 kilowatts per second, etc.

In view of the widening scope of methods of power generation some of these values for the horse-power should come into very general use, as indeed the electrical equivalent already has done. The extending use of power gas and of fuel gas renders it very desirable that the thermal equivalent of a given gas in heat units for any given volume consumed per unit of time, may be converted directly into its horse-power value, and similar conversions in connection with water power are of frequent use. For purposes of comparison there is little doubt that the expression of the duty of a steam engine in thermal units possesses numerous advantages, although, as is plainly pointed out, there is no physical difference between the two statements of the measurement, the only actual difference being a purely arithmetical one, as indeed is the case with all of the equivalents. There is, however, a vast convenience in dispensing with the intermediate arithmetical labour, beside the removal of some source of error, and the term horse-power has now gotten so far away from Watt's experiments with animal power that the origin of the term is hardly ever conveyed by the name.

"It is to be hoped that there may never come upon us any movement in favor of the use of a variety of physical units of horse-power—that is, of horse-power units of really differing physical quantity. In English linear measures we use the units the inch, foot, yard, and mile, and the result is great inconvenience and unnecessary labour. As regards rates of doing work, we have already two great unit measures—horse-power and kilowatt. It is greatly to be desired that no further diversity than this already established duality of measuring unit should be introduced."

Review of the Continental Press

The Gas Engine and the Smoke Problem.

Ever since the introduction of soft coal as fuel, the smoke problem has been with us, and with the enormous growth of power plants and manufacturing establishments within municipal limits, the production of smoke has in many instances become a nuisance for the abatement of which legislation has been invoked. In Paris a systematic series of trials has lately been concluded in order that the authorities might know to what extent smoke prevention was practicable, and in Philadelphia, the Board of Health caused the subject to be investigated most thoroughly by the Franklin Institute, with the same end in view.

Most of the remedies which have been suggested for the abatement of the smoke nuisance are based upon the more thorough combustion of the coal, either by regulating the admission of air in the furnace, or by more effective intermingling of the air and gases during the operation of combustion, and while it has been demonstrated that with proper care soft coal can be burned under boilers with the production of little or no smoke, it has also been clearly established that there is no especial economy in so doing, and that any efforts to induce owners to install apparatus for smoke prevention must be for public benefit without including any advantage to those by whom the expense is borne.

Another method for the abolition of the production of smoke in power generation is discussed by Herr Joh. Korting in a recent issue of the *Zeitsch ift des Vereines deutscher Ingenieure*, this being also a method which involves a marked economy in power generation as well.

The high economy of the internal combustion motor, either in the form of a gas or a petroleum engine is well known, and even the least economical gas engine is far beyond the performance of the best steam engine possible, while the later forms of internal combustion motor show a thermal efficiency several hundred per cent. of that of steam engines of the same size and power. When it is remembered that all these gas and petroleum motors are absolutely smokeless in their action, it appears that it is along this line of power generation that the complete solution of the smoke problem must be made.

Assuming that these facts are accepted, Herr Korting discusses the subject from the very practical side of cost, both of installation and operation, taking the Korting gas engine as a typical gas motor, and the Diesel motor as a petroleum engine, and by means of comparative curves shows the relative cost of power from these sources; using illuminating gas at various prices, as well as power gas in the gas engine, and fuels of various costs in the Diesel motor. Curves for simple and compound engines, with and without condensation are also given, the capacities extending from 10 to 400 horse-power, the diagrams thus enabling the relative economy of the different motors to be seen at a glance.

So far as operative economy is concerned the gas engine, when operated with fuel gas shows a decided commercial advantage over steam at all powers, although the gain is less at the higher power than for the smaller sizes. This, however, is not because the gas engine is less economical at large power than at small, but because the wasteful performance of small steam engines is proportionately greater. The commercial economy of the petroleum motor is by no means so great as its thermal efficiency would indicate, this being due to the cost of the fuel, and as producer gas can be made from very cheap and inferior fuel, this compensates for the somewhat lower thermal efficiency of the gas engine.

The principal hindrance to the general introduction of the gas engine as a substitute for steam power lies in the fact, that, as yet, but little experience has been had with the larger sizes. That the large gas engine is an assured certainty, however, is the opinion of the best informed experts in this line of work, and in the pages of

this magazine, a little more than a year ago, Mr. Dugald Clerk said: "There can be little doubt that in ten years, gas engines of 1,000 horse-power will be as common as engines of 100 horse-power are now." In view of the fact that a successful Westinghouse gas engine of 750 horse-power has already been constructed, it appears that the capacity given by Mr. Clerk may be reached in a shorter period than ten years, and in any case the large gas engine will undoubtedly make its appearance on a commercial scale so soon as a strong enough demand shall have been created for it.

This demand, according to Herr Korting may appear at first, not in the form of a requirement for great economy, but from the enforcement of legislation against smoke-production, and when it is realised that the highest known economy includes with it absolute freedom from the production of smoke, the importance of the internal combustion motor will be doubly emphasized.

The Traveling Sidewalk at Paris.

THE idea of a traveling sidewalk is by no means new, as it had been suggested several times before it was practically tested at the World's Fair at Chicago in 1893, and since then another successful installation has been made in Berlin. These examples, however, were but small affairs compared with the very extensive plan proposed for the Paris exposition by M. de Mocomble, concerning which notes have already appeared in these columns, and a full description of which was given in the March issue of THE ENGINEERING MAGAZINE. The proposed sidewalk for the Paris exposition is to be so much larger than any of its predecessors, being 5 kilometres in length (more than 3 miles), that the exposition authorities thought best to require the contractor to construct a preliminary section, and show it in full operation under severe tests, before his plans should be finally accepted.

This preliminary trial has now been held, and from a fully illustrated account in a recent issue of *Le Génie Civil* the results are obtained. This trial platform was constructed exactly as the plans had been made for the final scheme, with the exception of the length, the experimental section being an oval of about 410 metres perimiter (1.350 feet) with a short re-entrant curve on one side, in order to test the behaviour of the mechanism under such conditions, and a slight grade of 0.3 per cent, at two points.

The sidewalk consists of three parallel platforms, the outer one being stationary, the next having a speed of 4 kilometres, and the inner one a speed of 8 kilometres, per hour. With these speeds it is found very easy to step from one to the other at any point, so that all delays from stoppage for entrance are eliminated, and this fact, together with the enormous carrying capacity, renders the moderate speed ample for prompt conveyance to any part of the line.

Each of the moving platforms is composed of 32 sections, with semi-circular ends, there being short intermediate sections between each of these, with ends shaped to fit, so that the entire circuit is covered, and no joint is opened as the platform bends and straightens. The platforms each have their own tracks and independent electric motors, a three-phase current of 600 amperes, and 220 volts being provided by a dynamo of the Alioth type.

The practical results of the trials of this preliminary apparatus were very satisfactory, although some defects were revealed, which can be avoided in the final structure. The sidewalk was operated successfully in very unfavourable, snowy weather, carrying more than 1,500 persons at once; the total weight of the platforms, in this case being 250 tons, and the power absorbed varying from 40 to 45 kilowatts. A variation of 60 tons in the load produced a corresponding variation of about 5 kilowatts in the energy required for propulsion. Experiments were also made by loading the entire platform with pig iron to 400 kilogrammes per running metre (252 pounds per running foot), and also by applying a concentrated load of 50 tons upon a single section, without producing any injurious effects.

The trials showed that no difficulty was experienced, even by persons possessing little agility, in stepping from the stationary platform to the moving sections, it only being necessary to step *with* the moving platform. The only serious objection which the trials revealed was that of undue noise, caused by the slippage of the axial girders

of the moving platforms against the stationary driving wheels. This objectionable feature, it is believed, will be obviated in the completed platform of the exposition, the experience with this temporary structure having shown it in time.

There is no doubt that this traveling sidewalk will remedy to a great extent the inconvenience which would otherwise have been caused by the distances which separate portions of the exposition, as it will practically connect all parts of the Champ-de-Mars with the Esplanade des Invalides and the Quai d'Orsay, and although it cannot be extended to the right bank of the Seine, yet it will deliver passengers to the entrance of the Alexandre III. bridge and enable them to reach the Champs Elysées simply by crossing the river.

The principal criticism which has been made of the plans of M. de Mocomble is the momentum which will be acquired by such a large, continuously moving mass, and the liability to serious dislocation of the whole, should any sudden stoppage occur. It must be remembered that the total weight will not be materially greater than that of many freight trains, in the United States, at least, which are hauled at greater speeds, and are successfully managed without difficulty from this cause.

Reinforced Concrete.

THE extremely rapid development of the use of concrete reinforced by imbedded metal in construction renders it almost impossible to keep pace with the applications except by maintaining a close watch over the recorded accounts in the technical press. In the current journals we have two notable papers upon this subject, one being a very thorough discussion by Professor Ritter, in the *Schweizerische Bauzeitung*, of the Hennebique system and the other an account in *La Revue Technique* of the curious and very economical X shaped bridge at Mans, this latter paper being practically an investigation of the entire subject by M. Harel de la Noë, Chief Engineer of the Ponts et Chaussées.

The close relation existing betwen these two articles renders it desirable that they be reviewed together, forming as they do a joint discussion of both the practical and theoretical sides of the subject.

The possibility of using iron and concrete in combination depends upon several important properties, the truth of which has been demonstrated experimentally beyond doubt. These properties are: 1, that the coefficients of expansion of iron and cement are practically equal; 2, that cement adheres very strongly to iron, the German experiments indicating 45 kilogrammes per square centimetre, (640 pounds per square inch); 3, that concrete possesses enough elasticity to allow it to stretch, without cracking, to an extent sufficient to permit the tension stresses to be sustained by the inbedded metal.

As is well known the Monier system of reinforcing concrete is by means of inbedding a network of interwoven wire, while in the system bearing the name of Professor Melan, rolled beams, or even lattice girders, either straight or arched, are used as a sort of skeleton about which the enclosing mass of concrete is moulded.

The Hennebique system, used to some extent in Switzerland, lies midway between these two, but is somewhat simpler than either. It uses as a reinforcing material, round iron rods, ranging from ⅜ inch to 1½ inches diamter, these being so placed as to be as far as possible from the neutral axis on the tension side, and interlocked with the whole mass of concrete by so-called stirrups of flat iron bent in U form about the rods, with the open end extending up into the concrete. Such a system of rods and stirrups when used in connection with concrete made from first-class cement enables flat floors to be made without any arching or other support between beams, with a sustaining power of 200 to 400 pounds per square foot, and a similar arrangement permits arches of great strength to be constructed very cheaply and rapidly. Professor Ritter goes very fully into the relative proportions to be observed between the section of the rods and the concrete, and shows how the strength of the combination may be computed in a simple manner.

The double bridge at Mans is noteworthy for its form, as well as its mode of construction, there being really two bridges in the shape of a letter X, the interesection being in the middle of the crossing of the River Sarthe. One portion of this combi-

nation carries an electric tramway and the other half of the X is for a local steam railway from Mans to St. Denis d'Orques. This peculiar necessity of construction was complicated by the fact that the limited funds available made it necessary to keep the entire cost of the work down to 45,000 francs, or about 90 francs per square metre, while the Pont Ysoir, which crosses the Sarthe within a few yards of the new bridge, cost 288 francs per square metre, not including the foundations.

Under these circumstances recourse was had to reinforced concrete, as offering the best method available for obtaining a reliable structure at a low cost, and the result has fully justified the wisdom of the course. The new bridge is substantial, both in appearance and in fact, and is not inartistic in effect, while the actual cost, including foundations and piers, was only 33,000 francs, or 66 francs per square metre!

This low cost was partly due to the use of old rails as a material for reinforcement of the cement, and the success with which this material has been used in this case will doubtless lead to a repetition of the practice elsewhere. The piers consist of a foundation of a grille of rails laid crosswise, and buried in concrete. Upon these were erected hollow pillars, made of blocks of concrete, with four rails placed vertically in the interior space, with cross cramps of flat iron interlocking them to the outer blocks, the whole interior being then filled with concrete, run in so as to bind the whole into a firm mass.

The superstructure is composed of built-up girders, resting upon the piers, the flooring being composed of transverse arches turned between cross beams of imbedded rails, the whole forming a very strong, effective and substantial structure.

One of the most economical features of the system of reinforced concrete lies in the ease with which simple materials can be utilized, while the absence of carefully fitted connections, and of much detail of erection work, tends greatly to eliminate expense.

There is little doubt that this form of construction, in some of its many varieties, is destined to enter very largely into future work in many places, and for ease of erection, moderate cost, and security against fire, it has much to recommend it.

A Unique Water-Works.

THERE has recently been completed at the little seaside village of Yport, on the French coast of the Channel, a water-works plant, which, although quite small, is most interesting, and from an account in *Le Génie Civil*, some of the peculiar features of the installation are abstracted.

The source, or rather sources, of the supply are a series of springs, situated on the pebbly beach at the foot of the chalk cliffs, and entirely covered by the sea to a depth of more than 10 feet at high tide, while as the tide falls the pure water flows up forming bubbling pools several metres in diameter, like the discharge of a submarine river through the gravel of the beach.

The water from these springs has been entrapped in small intake reservoirs built in the rocks, protected against the entrance of sea water, and filled by the fresh water as the springs are uncovered by the falling tide. As the beach is close to the foot of the cliffs at this point, and the town lies back in a hollow among the rocks, the water must be delivered to a reservoir upon the higher part of the cliffs. This is accomplished by piercing a short tunnel into the face of the cliffs opposite the intakes, and constructing a vertical shaft to the upper surface of the hill. A pumping chamber, excavated in the chalk about the middle of the tunnel, contains the pumping machinery, which draws the pure spring-water from the intakes and forces it to the reservoir 250 feet above.

There are two sets of pumps, driven by vertical petroleum motors of the Noël type, the pumps being geared to the motor shafts, and the whole arrangement being compact and symmetrical. The pumps can be thrown out of gear while the motors are being started, and gradually engaged with the work by means of friction clutches.

From the nature of the supply the plant can only be operated for a portion of the time, the best results being obtained at about half tide. When the water is high the supply is naturally brackish, while curiously enough, at very low tide the flow of the springs almost ceases. This latter phenomenon is explained by the fact that there are probably numerous other outlets to the subterranean water supply, which are uncovered at very low tide, and that the gen-

eral relief at the lower level checks the flow of the higher outlets. In practice it is found that pure water can best be obtained by two pumping periods per day, of six hours each, the time being midway between high and low tide, although experience has shown that in stormy weather, when the tides may be higher than usual the agitation of the surface prevents the salt water from sinking into the pits, and fresh water is drawn by the pumps even when the springs are covered by several feet of sea water.

With the plant as at present arranged a supply of pure water of about 60 gallons per day per capita is readily obtained, while the installation of another pumping engine would enable this to be proportionally increased without difficulty, the flow of the springs being ample for an increase of population.

Yport has long been looked upon with favour as a seaside resort, lying as it does between Fécamp and Etretat, but until now the absence of a satisfactory water supply has prevented it from becoming popular. The present works remove entirely any objection on this score, and both as a neat solution of an engineering problem and as a municipal improvement this little installation is well worth noticing.

The Influence of Temperature upon Alloys.

In a recent issue of this magazine the exhaustive experiments made at the Royal Testing Laboratory at Charlottenburg upon the effect of heat upon the strength of copper were discussed at length.

At that time it was noted that the effect of heat upon strength was influenced to a marked degree by the presence of small quantities of other metals, and it was suggested that for locations where the material was to be exposed to heat, it was probable that certain alloys might be better adapted to the purpose than the pure metal.

This subject is discussed in a very thorough manner in a long paper by M. Georges Charpy in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, devoted especially to the very complete researches of M. Andrea Le Chatelier upon the influence of temperature upon metallic alloys, as well as upon the tests made by the author himself.

The trials were made by two methods, using the tension test in a horizontal Maillard testing machine, and also the drop test.

In the former method the test piece was heated by immersion in a bath of oil, the connections with the heads of the machine being made with strong yokes which permitted the specimen to be immersed in the oil during the application of the stress. In the application of the drop test it was more difficult to effect the heating, as it is impracticable to apply the heat to the piece in place and when the specimen is heated before clamping it is apt to cool before the application of the test. The latter method was adopted, however, taking especial precautions to avoid loss of heat.

In the complete paper of M. Charpy the details of the tests are fully given, including chemical analyses of the alloys, and graphical diagrams of the results, and we can only give here the general conclusions which are drawn, with some comments upon the practical applications.

In general the following results have been determined by comparison of many experiments:

Pure copper diminishes in strength regularly with an increase in temperature, the rate of diminution of strength being represented by the formula:

$$R = 21 \text{ kg} - 0.025\ t$$

t, being the temperature in degrees centrigrade.

Alloys of copper and tin give results which vary greatly according to the composition of the specimen. In some cases there is a rapid falling off in strength and elongation at temperatures exceeding 180° to 200°C., as shown by the experiments of the British Admiralty and of Professor Unwin. In other cases the strength is well maintained up to 250°C., this always being the fact with phosphor-bronze, and in some instances with bronzes in which no deoxidising material is employed.

Aluminum bronzes exhibit a peculiar behaviour, showing a sudden drop in strength between 80° and 150°, this being only 5 or 10 kilogrammes for drawn or rolled metal, but reaching a much greater amount for cast specimens.

All kinds of common brass show a rapid diminution in strength and elongation from 250° to 300°C.; the breaking resistance at

250°C. being only about 15 per cent. of the value at ordinary temperatures.

Brasses containing 1 per cent. of aluminum show a higher resistance at elevated temperatures than bronze or rolled brass, giving a resistance of more than 20 kilogrammes per square millimetre, (28,000 lbs. per square inch), with a considerable elongation up to 260°C.

In the case of iron and steel the breaking strength diminishes for temperatures varying between 60° and 100°C. according as the metal is more or less hard, after which it increases until it attains a maximum at about 250°, then decreasing rapidly beyond 300°.

The difference in strength between 15° and 250° is at least 8 to 10 kilogrammes, whatever be the hardness. The elongation varies in the inverse direction to the resistance. The reduction in section diminishes continuously from the ordinary temperature up to 300° or 350°, while above 400° it increases very rapidly, becoming very marked at 700° and 800°.

The importance of these researches is evident when it is considered that the continual increase in steam pressures now so general is rendering it most necessary that the strength of all materials in contact with high-pressure steam should be known in connection with the temperatures at which they are used. Many parts of steam machinery which are proportioned with ample strength, based upon tests made at ordinary temperatures, are altogether insufficient when the reduction in strength by heat is considered. The researches of Le Chatelier, Charpy, Roberts-Austen, Martens, Unwin, and many others are furnishing ample material to enable such errors to be avoided, and by changes in dimensions and proper choice of materials the changed conditions may in great measure be met.

Electricity on Main-Line Railways.

THE rapidity with which electric power has been applied to the operation of tramways and of short local railways has led to many predictions as to the invasion of the domain of main-line railways, and the disappearance of the steam locomotive from active service before many years shall have elapsed. A recent issue of the *Zeitschrift des Vereines deutscher Ingenieure* contains an exhaustive review of the present state of the problem by Herr C. P. Feldmann covering what has been done, not only on the continent, but also in the United States.

By way of effecting a proper comparison of cost in operating railways with steam or electricity, Herr Feldmann begins by examining the progress which has been made in economical transport under existing methods during the past thirty years, showing by plotted curves the manner in which the rates have been reduced, and giving an excellent opportunity of examining the advance which electric driving must make if it is to stand on an economic equality with steam in this respect. An examination of these diagrams shows that the transport of merchandise is the principal source of revenue of main-line railways, and that under existing conditions, as well as under those which will probably obtain in the approaching future, steam locomotives will continue to prove more economical than electricity.

With passenger transportation, however, the conditions are very different. By far the greater number of passengers is included in the local and short-distance runs, and the long-distance passenger traffic forms a minor portion of the business and one from which the revenue forms a secondary consideration compared with the important and profitable local business. It is for the handling of this local traffic on the branches of main-line railways that Herr Feldmann sees the important function of electric power, and in support of this view he cites the success of many installations, mostly from American practice.

There is little doubt of the fitness of electric power for this local service, but this may more justly be regarded as an extension of the shorter line tramway roads, which have developed so enormously of late, than as true main-line service. Electricty, however, has already shown itself to possess advantages for certain branches of main-line business, apart from any claims to superior economy, and among these may be noted freedom from smoke and gas, besides relief from the necessity of transporting supplies of fuel and water. The electric locomotives in the Baltimore tunnel may be cited as one instance of the

value of smokelessness, and another is seen in the report of the adoption of electric power in the prolongation of the Orleans railway in Paris; and the extension of successful practice in such partial installations to other portions of the roads is a feature which may only be dependent upon the demonstration of practical advantages.

The introduction of electric power has only been delayed by such abnormal devices as the Heilmann locomotive, which united the disadvantages of both steam and electricity; but, from the nature of things it is evident that some more effective method of hauling loads over railways should be found than that of using a portable power-house for every train, as is now the practice. The relief to the roadway by the substitution of rotary for reciprocating motors is a feature which should also be considered in making up the balance of cost, and until the entire advantages of electric-driving are fully demonstrated it will continue to be difficult to make intelligent comparisons which shall take all the controlling elements into account.

Railway Trestles in Austria.

THE use of the iron trestle bridge for railway viaducts has been mainly limited to the United States, but in a recent issue of the *Zeitschrift des Oesterr, Ingenieur und Architekten Vereines* a description is given of some examples of trestles quite on the American plan, which have been erected on the line of the Waidhofen-Gaming local railway.

The circumstances which led to the choice of this somewhat unusual construction in Austria, were the necessity of crossing two valleys at points where the widths were 300 and 350 feet, and the depths 65 and 85 feet, while in one case these conditions were combined with grades from 2.5 to 3.2 per cent., and a curve of 200 feet radius. These conditions made the use of arches or long-span trusses inexpedient, both on account of expense and constructive difficulties, and hence the very American looking trestles which are illustrated in the article were adopted.

The construction of the curved portion of the viaduct has been very well worked out, the wide spread which is given to the central trestles insuring ample stability, notwithstanding the tendency to lateral deflection, caused by passing trains, while the details of the bracing and the arrangement of foundations give stiffness with moderate weight.

While to the railway engineer, familiar with American practice, these trestles offer little or nothing new, the fact that this simple and economical method of spanning valleys, regardless of grade or curve has found its way into Austria is but another example of the rapid international exchange of engineering ideas now everywhere so apparent.

The Action of Sea Water on Alloys.

THE use of copper and its alloys as a material for the sheathing of vessels, and in other locations where it is exposed to contact with sea water, renders it most desirable that a knowledge of the behaviour of materials of a known composition should be determined so far as corrosion is concerned. For this reason the German government has caused a number of tests to be made, and from the report of Chief Engineer Diegel, very fully abstracted in *Stahl und Eisen*, the principal results of these investigations are taken.

Since the experiments extended over a period of two years, and were conducted with great care and thoroughness, there is every reason to believe that the information thus acquired is the most complete contribution to knowledge in this direction which has yet been made.

The tests were made by suspending the specimens into the sea water from a bridge in the harbour of Keil, so that they were exposed to the action of the water in a manner similar to that which occurs in actual practice. Twelve strips were cut from a sheet of the metal to be tested, nine being suspended in the water and three being retained for comparison. At intervals of eight months three strips were taken out of the water and broken in the testing machines as was also one of the reserved pieces, and thus a comparison of the exact deterioration due to differences in location could be determined. Tests were thus made with immersions of 8, 16, and 24 months, and in addition some trials were made after immersions of 16 and 32 months.

As the atmosphere is known to have an injurious effect upon alloys containing much zinc, specimens of such allows were also exposed to free contact with the air, in order that the loss of strength from this cause might be determined.

The trials were limited to such alloys as are actually used in shipbuilding, or which are likely to be considered for such work, there being the following five groups: copper alloys rich in zinc; bronzes containing little zinc; pure tin-bronzes; pure aluminum bronze and iron aluminum-bronzes.

The results of these tests are given at length in the original report, with diagrams showing the relations of the various alloys, but for this the original paper must be consulted. We can give here, however, the general conclusions which were drawn from the behaviour of the different materials, and some comments on their application. Considering first the behaviour of the specimens in air, it was found that the iron-bronze alloys resisted atmospheric influence remarkably well, there being practically no deterioration in strength during two years; those alloys containing much zinc did not behave so well, but no tests were made as to the resistance of the iron-zinc bronzes to the action of the air.

When immersed in sea water in contact with iron, the iron, tin, and aluminum bronzes all retained their strength very well. After exposure to the water for 2 to 2½ years there was no marked difference in appearance, nor was there any reduction in weight, while tension tests showed no reduction in strength. Iron bronzes in contact with tin bronze showed a material loss after exposure to sea water, the zinc dissolving out, but this action was less rapid with the aluminum bronzes. A specimen of iron bronze in contact with tin bronze after two years' immersion in sea water showed a loss of ⅗ of its original strength and 4-5 of its extensibility, and the structure was partially destroyed by the eating away of the zinc. Cast and wrought bronzes appeared to be equally affected. A wrought plate of iron bronze in contact with a cast plate of the same material was rapidly affected, and in two years its strength was diminished by about 60 per cent. An iron bronze and a phosphor bronze, attached to a piece of oak, showed a slow corrosion of the iron bronze, 20 per cent. of its strength being lost in 23 months.

The important conclusion which was drawn from the experiments was the influence of the metal to which the sheathing is attached. Thus, for instance, tin and iron bronzes both give good results in contact with iron, but are injuriously affected in contact with each other, while the iron itself is least corroded when sheathed with an iron bronze.

The principle which governs the corrosive action between different metals is that of their relative position in the electrical scale, and the same considerations which govern the choice of metals for galvanic action enter into the question of injurious corrosion. Pure aluminum bronze, for example, resists the action of sea water remarkably well when in contact with metals which are electro-negative towards it, while contact with electro-positive metals causes its rapid destruction. It is therefore most desirable to place those metals in contact which are close to each other in the electrical scale, and any statement as to the resistance of an alloy or sheathing metal to corrosion is misleading unless it includes a description of the material with which it is said to be used.

REVIEW OF THE AMERICAN PRESS

Electricity on Board Ship.

THE important subject of the general use of electric power on shipboard, with especial reference to the electrical driving of auxiliary machinery was presented recently in a paper before the American Institute of Electrical Engineers by Mr. S. Dana Greene, and elicited an animated discussion, during which a number of interesting points were brought out.

The advantages of centralizing the generation of electrical power in one plant and its distribution by suitable means to individual users have long been realized in many cities, but little has been done in this direction on vessels, both because of the well known dislike of seafaring men to innovations, and also because of the difficult conditions involved in installing apparatus to be exposed to salt air, moisture and heat. The introduction of electric lighting, however, has prepared the way for the more general use of electricity, partially overcoming the prejudices of the seamen, and also furnishing the electricians with valuable experience in contending with the peculiar conditions of the service.

In certain directions everyone now admits the suitability of electric driving for the innumerable power-requirements on shipboard, other than the main engines. No other method admits of a safe, cool and flexible system of distribution. Electric motors can be placed anywhere, may be started from any desired point, emit no exhaust discharges, and as now built, are entirely reliable. It will undoubtedly be necessary to enclose and protect the motors against weather and water, but the difficulties attending such protection are no greater than have been successfully overcome in the case of street car motors. The experience on board the Brooklyn during the war with Spain showed the superiority of electric motors over steam in the one point of reliability alone, two of the turrets having been fitted with steam motors and two operated by electric motors. There is therefore no question among well-informed engineers as to the practicability of making electric power entirely reliable for all auxiliary work on shipboard.

The next question is the advantage which may be obtained by the change. In the first place, a great gain in economy may be expected by the substitution of a central power plant for the innumerable small steam cylinders now used on every steam vessel. The trials of the Minneapolis, the Terrible, the Argonaut, and other vessels, have shown that the auxiliary steam machinery requires from twenty-five to forty per cent. of the total amount of steam generated by the boilers, the loss being especially great when the vessel is cruising under part power, and when economy is especially desired.

Mr. Greene shows very conclusively that by the use of a central power plant and electric distribution and driving for the auxiliaries, nearly seventy per cent. of the steam now required can be saved, and although the steam consumption could undoubtedly be reduced very materially by compounding, and by the introduction of other improvements, the cost would still be 100 per cent. in excess of that required for electric driving.

"The applications of electric driving to the various ship auxiliaries must be carefully studied in each case. The problems involved, however, are not more difficult than many special applications on shore, nor is there anything about them which a competent electrical engineer, with a proper knowledge of sea conditions, is unable to solve. The first cost will undoubtedly be greater than with steam driving, but the saving in operative expense, if capitalized, will much more than offset this difference in first cost."

The question of obtaining and retaining in the naval service men competent to operate and care for electric machinery, received some discussion in connection with Mr. Greene's paper, but there seems to be no good reason why this should not be accomplished in the navy with at least the same

measure of success as has been readily attained in stationary power house practice and in tramway service. In nearly every case the electric motors are simpler, and require less care than do steam auxiliaries, and the ease with which very ordinary labor manages electric cars under most trying conditions would seem to warrant freedom from anxiety on that score.

The question of the healthfulness of a vessel which is free from the innumerable steam pipes and excessive heating is also a matter for consideration. The recent experiences in the tropics have demonstrated that vessels equipped in northern latitudes contained many devices and arrangements which would have been made very differently had the builders been familiar with tropical conditions, while the ease with which ventilating motors can be placed wherever necessary when electric power is available, is certainly a consideration.

The suggestion has been made that two vessels, otherwise identical shall be fitted out, one with steam auxiliaries, and the other with an electrical equipment, and exhaustive comparative trials made; and many men feel that the results would be greatly in favor of the electric driving.

The Production of Gold.

AN interesting paper by Mr. A. E. Outerbridge, in the *Popular Science Monthly*, calls attention to the great increase in the gold production of the world in 1898 over that of 1897, and as much of this increase is undoubtedly due to the application of engineering and scientific methods to mining operations, some of the points treated are of technical importance.

"The output of gold in the United States in 1898 was more than twice that of 1890; and the production of gold in the world in 1898, at the lowest estimate, was more than twice the estimated production in 1890."

While a portion of this great increase has come from the discovery of new workings, by far the greater portion of the gain in the past few years has been due to the application of methods for dealing with ores of such low grade that they were formerly unprofitable for working. The introduction of the cyanide process has not only enabled "tailings" formerly thrown aside as unworkable, to be treated at a profit, but has rendered possible the treatment of very low grade ores, in some cases such as contain less than one-quarter of an ounce of gold distributed through a ton of ore. In the United States there are now about twenty-five cyanide plants, while in South Africa, where the process has received its greatest development, there are more than forty plants. The success of these plants has caused attention to be directed to the possibility of considering gold-getting in the light of a manufacturing business, involving not merely a mine or source of ore, but also a large manufacturing and engineering plant, the permanent investment of a large amount of capital, and all the organization of a great industrial enterprise. In many cases such a business includes the employment of much machinery, including appliances for dredging the river beds or conveying large supplies of water over long distances, and from being the vague lottery of past years the conduct of gold mining is rapidly becoming a scientifically conducted business operation, not greatly different from the mining of coal, iron or copper.

This view of the subject relates principally to the business of extracting gold from low-grade ores by scientific methods on the large scale, where the precious metal is evenly distributed throughout the matrix of gangue, and since the element of chance is practically eliminated it is a legitimate field for the investment of capital, altogether different from the lottery of digging for nuggets.

The extent to which scientific and engineering methods will develop the rate of gold production cannot be foreseen, but there is no lack of low-grade ore upon which processes can be employed. Indeed from this point of view there are many things which come under the title of ore, which can never be expected to offer a commercial profit. Mr. Outerbridge refers somewhat humorously to the fact that the clay underlying the city of Philadelphia has been demonstrated to contain more gold than has been brought from California and Australia, and we have all heard of late of the importance of the waters of the ocean as gold ore, but apart from such chemical curiosities as the detection of a trace of the precious metal in some com-

mon material, there are undoubtedly many ores, now too low in grade to be considered as commercially practical for working, which may become fairly profitable when treated on a very large scale by methods yet to be developed. Gold hunting is certainly in a fair way to be wholly removed from the sphere of adventure and chance, and entirely included in the domain of engineering and scientific industry.

Engines for Superheated Steam.

In the course of a recent discussion before the American Institute of Electrical Engineers, Professor Elihu Thomson described a form of single-acting steam engine which is remarkably well adapted to be operated by steam of high temperature, and with which he said that he had obtained most excellent results. This engine, which Professor Thomson states is very similar to that which M. Serpollet is using in his steam motor vehicles in Paris, consists of a single vertical cylinder, open at the bottom, and fitted with a plunger piston to which the connecting rod is directly attached. Openings are provided to the atmosphere through the wall of the cylinder in such position as to be uncovered when the piston arrives at the end of the stroke, while steam is admitted at the beginning of the stroke by a poppet-valve at the top. The action is as simple as the construction. High-pressure superheated steam is admitted for a short portion of the stroke and then cut off, and when the piston reaches the end of the stroke the steam exhausts through the openings which are uncovered by the piston. The return stroke is produced by the momentum of the fly-wheel, and the steam which is entrapped in the cylinder after the exhaust openings are closed, is compressed in the clearance space, which is so proportioned as to give the desired degree of compression.

Professor Thomson explains the high economy attained by the engine of this type which he has constructed, by the following considerations. Instead of reversing the motion of the steam during the exhaust, and throwing it back over the heated surfaces, the steam always flows in a forward direction. The incoming steam comes in contact with highly heated surfaces, thus reducing cylinder condensation to a minimum while any water of condensation, instead of being re-evaporated, is thrown out through the exhaust opening at the end of the stroke. The cylinder full of exhaust steam is compressed on the return stroke nearly or quite up to the initial pressure, and is thus superheated again to meet the incoming live steam, and so heat losses through the cylinder walls are reduced to a minimum. The whole action is somewhat similar to the gas engine, except that it uses a double, instead of a quadruple cycle.

A small four-cylinder engine of this form, with cylinders 2½ inches diameter, 3 inches stroke, using highly superheated steam at 160 to 200 pounds pressure, has, according to Professor Thomson, given the result of 20½ pounds of steam per horse-power-hour, certainly a remarkable economy for so small an engine.

It is most interesting to note that this engine is an almost exact reproduction of the famous engine built by Jacob Perkins early in the present century, and which attracted so much attention, both in London, where it was operated publicly, and also in the United States, of which Mr. Perkins was a native. The Perkins engine used steam at 800 pounds pressure, admitted it by a poppet-valve actuated by a cam, giving a prompt cut-off, and then exhausted through openings uncovered by the piston at the end of the stroke in a manner identical with the engine described by Professor Thomson. The steam remaining in the cylinder was compressed in the same manner, and there appears to be an absolute identity between the two machines.

The Perkins engine is very fully described and illustrated in Galloway's History of the Steam Engine, published in 1830, and also in the Journal of the Franklin Institute for 1827, and both in his ideas of the generation and the use of steam, Perkins is seen to have been far ahead of his time. The true reason for the failure of his engine to attain commercial success, was the same which has delayed generally the introduction of superheated steam, i. e., the mechanical difficulties connected with lubrication and packing at such high temperatures. A comparison of Perkins's

work with that of his contemporaries shows the excellent knowledge of design and construction which he possessed, while his theoretical views were quite in accordance with modern practice.

We have shown this entire anticipation, not for the purpose of detracting in the slightest degree from the efforts of Professor Thomson, for, on the contrary, we believe his experiments will go far to renew attention in this excellent form of engine, but rather to call attention to the remarkable manner in which Perkins grasped the true principles upon which steam economy could best be effected. With the improvements and advances which have been made in engine construction, and with the application of modern metallic packing and lubricants there seems to be now no good reason why engines of this type, using high pressure superheated steam, may not give the high results in commercial practice which Perkins predicted for them more than seventy years ago.

The Care of Drawings.

In the modern machine works, the drawing office forms a very important feature, both in the results which it produces, and in the proportion of expense which it causes, and every detail which increases efficiency and diminishes expense is worthy of careful thought. Various methods of classifying and indexing drawings have been adopted, and doubtless there are numerous good ones which differ widely from each other, and unfortunately there are yet machine shops which have no complete or systematic method of doing this important work, much being trusted to memory, and not made a matter of record.

A recent issue of the *American Machinist* describes the practice of two important establishments in filing and indexing drawings, noting that the two works differ widely in the character of their product, the one being devoted to moderate sized machine tools, produced upon a manufacturing basis, and the other undertaking the largest constructions, with few or no repetitions. The fundamental peculiarity in both of these establishments lies in the fact that the drawings are filed by size, and not by title. All drawings of a size are filed together, regardless of the machine to which they belong, and the location of the drawings for any machine is determined by reference to the index. Since the blue print system is practically in universal use, the drawings or tracings need not be used for any purpose except printing, or as subjects for subsequent tracings, and the full set of blue prints made for construction purposes from an assembled record of the entire machine and render the collective filing of the originals unnecessary. The index may be either in a book or on cards, although the card system is as superior for this purpose as it has been found in library and other work. If a drawing is removed from its place for any purpose, a special index card, bearing the number and title of the drawing, as well as the place and person to which it has been sent, can be put in the index at the proper place. The whereabouts of every drawing can thus be indicated at all times, the special card being removed and destroyed when the drawing to which it refers is returned.

It is the practice of one of the establishments to bunch together and store in a separate fire-proof vault, the full set of blue prints used in the construction of any machine, thus insuring against the possibility of loss in case of fire, and also preserving a record of the actual construction of a given machine or lot of machines, regardless of any subsequent changes which may be made in the standard drawings. This question of protection of drawings against fire is always an important one, and is met in various ways in different establishments. Where general elevation tracings of the entire machine are made, it is a simple matter to take photographs of the tracings on a reduced scale, a double-elephant sheet being readily legible when reduced to 8 by 10, or even 6½ by 8½, and such negatives, made on films can be stored in a very small space in a fire-proof vault. In case of a destruction of the originals by fire, enlargements from these are readily made, and the economy of storage is evident.

The filing and recording of sketches is a matter which is not always given the attention which it deserves. The too common practice of making sketches on loose sheets or scraps of paper, should not be permitted, each draftsman being provided with a book in which all sketches and com-

putations should be made, these being indexed in the same manner as a letter copying book. Apart from the importance of preserving all such preliminary work for possible future reference, the mere fact that it may be subject to examination will go far toward producing neat and accurate work.

While no general system of filing and indexing the products of the drawing room can be devised which shall be applicable to all establishments, the practice of leading shops will often furnish valuable ideas to others, and every shop, however small, should have some systematic method of caring for important things.

Electric Power in the United States.

THE development of natural sources of power and their transmission and utilization by means of electricity has been discussed so often in these columns and elsewhere that no enlargement upon the importance of the matter is necessary at the present late date. It is, however, desirable that the progress of this important branch of engineering industry should be recorded from time to time, especially as its development includes details of interest to the civil, mechanical, and electrical engineer, besides being of vital importance to the managers of works, both from the technical and commercial side.

A recent issue of *Power* contains a very full account of many of the power and transmission plants now in actual operation in the United States, together with some examples of electric power applications, and from this article some interesting facts as to the present status of the matter may be obtained.

As typical examples of modern practice three power-generating plants are described: The one at Minneapolis, Minn., and the two plants in Utah, one in the Ogden Canon, and the other on Big Cottonwood Creek.

"The plant at Minneapolis is of rather special interest in that it has displaced three steam stations formerly used as power houses by the Twin Cities Rapid Transit Co., whose street-railway systems extend throughout and between St. Paul and Minneapolis. All the power for these lines is now generated at one station, situated on the lower St. Anthony Falls, and transmitted to various points of distribution in the railway network."

Here 10,000 horse-power is generated by direct connected turbines, there being 8,000 horse-power produced as alternating three-phase current for transmission to St. Paul, ten miles away; and 2,000 horse-power, as continuous current for near-by service, the alternating current generated at a pressure of 3,450 volts, is reduced by step-down transformers at Minneapolis to 387 volts, and then converted into a direct current of 600 volts for delivery to the railway feeders. Although ten 1,000 horse-power steam engines were to be provided as an emergency equipment, there has as yet been no occasion to put any portion of it into service, the hydraulic power plant having worked so successfully since the start that no steps have been taken towards adding to the steam plant.

The Ogden Canon plant differs from that at Minneapolis, in that it is an example of the transmission of the entire output of the generating station to a great distance. By constructing a dam across the head of the canon, a reservoir of about 2,000 acres was formed, from which a pipe-line, 6 feet in diameter is conducted to the power house, six miles distant, a head of 450 feet being obtained. This is utilized by five impulse wheels connected directly to three-phase generators of 1,000 horse-power each, the generator voltage being 2,300, which is raised by step-up transformers to 16,100 volts for the transmission circuit. The current is then transmitted entire to a distributing station in Salt Lake City, thirty-eight miles distant and utilized for various purposes by well-known methods.

The plant on the Big Cottonwood Creek offers an excellent example of a modern plant, midway between those previously mentioned, both in origin and in application. Here, 3,000 horse-power is generated by a dam, reservoir, main, and impulse wheels, the diameter of the pipe-line being 50 inches, and the head of water 375 feet. This plant is situated about fourteen miles from Salt Lake City, and the three-phase current, raised to a pressure of 10,500 volts, is utilized at various points along the transmission route, as well as at the terminus. Thus a large flour mill, half-way between

the station and the city, is driven by the current, and a small town supplied with light; while several large smelters are supplied with both light and power, and are operated night and day throughout the entire year.

These three examples are typical of what has been accomplished in a number of other places, and yet the work of exploitation of the natural hydraulic power resources of the United States, not to mention other portions of the world, is but begun. It is becoming evident that for many purposes the possession of coal beds is no longer to be the cause of the command of industries which require power, and the very fact that those regions in which water-power is the most abundant are in many cases the ones in which coal is least plentiful and most costly, will lead to a re-distribution of the location of many industries in the immediate future.

Concerning the applications of electric power but little need be said, for they are becoming so familiar to everyone as to be well-known everywhere. Apart from questions of cost, the advantages of convenience, cleanliness, freedom from smoke, gas or heat, all enter into the desirability of this form of motive power. With the general introduction of cheap and convenient electric distribution of power a formidable rival to the factory system must eventually spring up, and it is already time for thoughtful manufacturers who are using customary methods of driving to compute the probable life of their plants by the progress of their competitors, rather than by the old-time methods of wear and tear.

Permanent Way Construction.

SEVERAL months ago there was published in *Engineering News*, a description of an improved method of construction for permanent way, consisting in the main of the use of longitudinal girders of concrete under the rails, instead of the usual cross ties, the rails being tied at intervals by suitable metallic distance pieces. This paper was reviewed at length in these columns—in the February issue of the current year, and now the subject is again brought forward in view of the publication, with editorial comments, of correspondence elicited by the original contribution.

There is little doubt that the present system of constructing permanent way by imbedding cross-ties in a mass of broken stone as a support for the rails, is open to improvement, but apparently all the correspondents are not of the same mind about the best method for improving the work. Such an able engineer as Mr. Gustav Lindenthal expresses himself as in favor of a longitudinal metallic support, as do other engineers; while various forms of clips, bolts and fastenings are suggested. The interesting feature about the whole discussion lies in the fact that no one appears to have a good word to say for the present system of cross-ties and loose ballast.

The whole subject of road-bed construction forms an interesting chapter in engineering evolution. The early roads were constructed with longitudinal stringers of wood, or with stone blocks, and those who are familiar with the schemes of Mr. W. B. Adams, nearly fifty years ago, will recognize how nearly some of the present girder rails approach his "suspended girder." The breakages due to the too great rigidity of foundations had their true origin, not so much in the foundations as in the rails, and with the present deep and stiff rails, and the still heavier and more rigid ones which have been proposed, it is a question whether a more rigid substructure may not be desirable.

So far as the use of wooden sleepers is concerned, there is little doubt that they can be replaced to advantage by metallic cross-ties. The experiments of the Liége-Limburg Railway, extending over a period of eighteen years, described very fully in the Bulletin of the International Railway Association by M. Renson, and reviewed at length in the issue of this magazine of December, 1898, showed the superiority of well-designed sleepers of steel. The form evolved by M. Post from the successive experiences with less satisfactory designs, seems to be adapted for the construction of a very successful permanent way, and, when used with the best modern heavy rail-sections, should give a degree of stiffness capable of serving even under the heavy train-loads and high speeds now common. It must not be forgotten that there is such a thing as making a road-bed too permanent, and that few modern constructions

are permitted to remain unchanged until worn out. If strength and stability under working conditions are fully attained, it is sufficient if the life of a construction is long enough to endure its probable period of usefulness, and modern experiences in nearly every line of engineering are demonstrating that many other things besides durability enter into the commercially valuable life of a device.

In regard to the use of stone ballast, it has yet to be demonstrated that it has any superior for latitudes in which much frost is to be met. Any substructure which depends for its permanence upon the sealing it against the penetration of water from above, is of doubtful value in northern climates, while loose ballast well drained has been found best adapted to meet this most insidious enemy.

Methods of Prospect'ng for Gold.

In investigating placer deposits for gold the usual method of prospecting has been the slow and expensive one of sinking shafts. The cost of thoroughly prospecting a piece of ground by this method is so great that few owners have felt able to investigate the property fully before beginning dredging, and in consequence of this fact, many dredging operations have proved failures simply because the really valuable portions of the ground were not worked.

In a paper by Mr. R. H. Postlethwaite, published in the *Mining and Scientific Press* a method of prospecting by means of the much cheaper operation of drilling is described, and from the close comparative results which have been obtained when both drilling and shaft sinking have been adopted, it appears as if the former method could be made a very reliable one.

The operation of drilling is a comparatively simple one, the principal feature being the care which is necessary in order to avoid obtaining untrustworthy results. By the use of a form of traction engine, provided with walking-beam and mast, a heavily weighted steel bit is lifted and dropped upon the point to be drilled, the bit being turned by hand for every stroke, and thus drilling a round hole about six inches in diameter. By allowing a small quantity of water to run in the hole the cuttings are churned into a thin mud, and this is removed by a so-called sand pump, consisting of a barrel with a valve at the bottom. This is lowered into the hole from time to time, the drill being removed, and thus the cut material is taken out, and can be panned at once. The drill is followed by an iron pipe, forming a lining for the hole, otherwise a deceptive estimate might occur through the caving in of some of the material on the sides of the hole. The whole operation is so very much cheaper than the sinking of shafts that it makes it possible to make a critical examination of a tract to an extent that will permit the subsequent operation of dredging to be intelligently conducted.

It is the application of just such mechanical methods to mining operations which is taking the business out of the old hit-or-miss category, and placing it where it belongs, with other business and engineering work, and there is every reason to believe, as has been indicated elsewhere in this issue, that the increase in the output of gold will largely depend upon the introduction of engineering methods.

Formulas for Train Resistance.

The publication of the formulæ for train resistance by Mr. John Lundie, noticed in these columns in the March issue, has resulted in much discussion in various quarters, and the whole subject is treated in a very thorough manner in the *Street Railway Journal*, by Mr. J. B. Blood, forming an excellent review of the work done by himself and others.

"Train resistance has been a subject which has figured largely in mechanical engineering. A great many men in the United States and in Europe have made attempts to formulate it in some convenient manner. Some of these men have been eminent technically, while others have been interested in the subject more from an operating or practical standpoint. Most have desired to make an empirical form of an equation which would best express the results obtained by experiment, irrespective of the different factors which go to make up these results; few appreciated that train resistance was a combination of factors, and that if any one factor was pre-eminently above the average the whole empirical formula would fall. Probably most of the

people who have worked upon this subject appreciated the different factors which go to make up resistance as such, but judging from their formulas they did not appreciate the function of these factors and their relative amounts, and also that they were liable to occur in different proportions under different conditions."

Mr. Blood reviewed at length the different formulas which have been proposed, from the one by D. K. Clark in 1854, down to the present time, and examined the character of the experiments and data on which they were based. Plotting the results obtained from these various formulas, after having reduced them to comparable form, he showed how variations appeared as the conditions upon which they were based were departed from.

It appears that at low speeds the plotted curve departs so little from a straight line that it was permissible to represent the results by an equation containing only the first power of the speed, while at higher speeds this does not hold good.

There are three main factors which go to make up train resistance: journal resistance, practically constant at all speeds; friction between rails and wheels, varying approximately with the speed; and wind resistance, independent of the weight of the train and varying as a fractional power of the speed. Grouping these as terms of a formula, and supplying coefficients determined from all available experiments, Mr. Blood gives a formula which appears to be rational, and to agree well with the data upon which it is based. With our present information, the coefficients must be considered as tentative, and subject to revision as further experiments furnish additional data, but there is no reason to change the character of the formula on this account.

Mr. Blood shows that the method of measuring resistance by coasting, as adopted by Mr. Lundie, is not new, but was used before the later dynamometric tests. He considers the method by pull, far more satisfactory, as approaching more closely the conditions of practice, but also thinks that calculations from the power exerted by electric motors offer the best chance for accuracy.

With the accurate methods now in use for measuring forces and other physical quantities there seems to be every reason why very accurate data should be obtained for the purpose of settling this important problem, and the concerted action of a number of the leading railway companies, as well as of the electric tramways, should make the accumulation of ample data a comparatively simple task.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* Boston, U. S. A.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, U. S. A.
American Journal of Science. *m.* New Haven, Conn.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, U. S. A.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bulletin of the Univ. of Wisconsin, Madison, U.S A.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Montreal.
Canadian Mining Review. *m.* Ottawa.
Chem.Met.Soc.of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Contemporary Review. *m.* London.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Electrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.

Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita, *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, U. S. A.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, U.S.A.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, U.S.A.
Fire and Water. *w.* New York.
Foundry. *m.* Detroit.
Gas Engineers' Mag. *m.* Birmingham.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating. *m.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs and Surveyors. Peoria, U.S.A.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kans.
La Ingenieria. *m.* Buenos Aires, Argentina.
L'Energie Electrique. *w.* Paris.
Locomotive. *m.* Hartford, U. S. A.
Locomotive Engineering. *m.* New York.
Machinery. *m.* London.
Machinery. *m.* New York.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U S. A.
Master Steam Fitter. *m.* Chicago.
Mechanical World. *w.* London.
Mechanical Engineer. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco, U.S.A.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, U. S. A.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Modern Machinery. *m.* Chicago.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, U. S. A
National Builder. *m.* Chicago.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineers' Club. *qr.* Phila.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, U.S.A.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Railway & Engineering Review. *w.* Chicago.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revista de Obras Públicas. *w.* Madrid.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitarian. *m.* Brooklyn, U. S. A
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* zürich
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, U. S. A.
Stahl und Eisen. *s-m.* Düsseldorf.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, U. S. A.
Stone. *m.* Chicago. Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston.
Terrestrial Magnetism. *qr.* Cincinnati, O.
Trans. Assn. C. E. of Cornell Univ. Ithaca, U. S. A.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. of Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago.
Western Railway Club Pro. Chicago.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, U. S. A.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING.

CONSTRUCTION.

Earthquakes.

Earthquakes and Building Construction. Review of a work by John Milne, which contains chapters on buildings and materials in earthquake countries which are of much value. 2500 w. Builder—March 4, 1899. No. 26517 A.

Lescasse on Building in Regard to Earthquakes. Part first gives a description of the Japanese building system, with criticisms. 2800 w. Ind Engng—Jan. 28, 1899. Serial. 1st part. No. 26338 D.

Fireproofing.

Fireproof Stable Construction. Illustrated description of a large stable in Chicago, which has an iron framework and an unusual form of concrete floor. 1000 w. Eng Rec—March 11, 1899. No. 26481.

London Methods of Fireproof Flooring. F. R. Darrow. Brief illustrated descriptions of the varied forms devised, with discussion of the construction in general. 1800 w. Brick—March 1, 1899. No. 26411.

Recent Improvements in Fire-Proof Construction at Chicago. Peter B. Wight. Illustrates and describes the Ayer Building. 800 w. Br Build—Feb., 1899. No. 26236 C.

Some Notes on the Preserving and Fireproofing of Timber and Timber Substitutes. Sherard Cowper Coles. On the various processes and the degree of success; the effect of the chemicals on the durability and strength of the wood, etc. 1500 w. Engng—Feb. 24, 1899. No. 26,371 A.

Foundations.

Stresses in Steel Foundations. Samuel B. Durand. An investigation of the principles governing the design of concrete steel building foundations. 3200 w. Eng Rec—March 11, 1899. Serial. 1st part. No. 26480.

Paris Exposition.

The Paris Exhibition of 1900. General description of plan, the buildings and means of conveying material, the Alexander Bridge, etc. Ill. 2800 w. Engr, Lond—Feb. 17, 1899. Serial. 1st part. No 26214 A.

Plastering.

Plastering, Plain and Ornamental. W. J. Hynes. Presented before the Ontario Assn. of Architects. Reviews the materials, their use and application. Discussion. 5700 w. Can Arch—Feb., 1899. No. 26276 C.

Reinforced Concrete.

The Hennebique System of Construction. (Die Bauweise Hennebique.) Prof. W. Ritter. A full discussion of this simple and effective method of reinforcing concrete with rod and strap iron; showing numerous applications, and the method of computing proportions. Three articles. 6000 w. Schweizericshe Bauzeitung—Feb. 4, 11, 18, 1899. No. 26748 each B.

The Mining and Metallurgical Building at the Exposition of 1900. (Le Palais des Mines et de la Métallurgie à l'Exposition.) Especially illustrating the use of expanded metal in connection with reinforced concrete, on some of the buildings of the Paris Exposition. 1000 w. Revue Technique—March 10, 1899. No. 26715 D.

See Civil Engineering, Bridges.

Stables.

The Acker, Merrall and Condit Stables, New York. Illustrates and describes two large stables for a firm in the wholesale and retail grocery business. 4500 w. Eng Rec—March 18, 1899. No. 26578.

Terra-Cotta.

Terra-Cotta. M. J. Hynes. Read before the Ontario Assn. of Architects. The utility and beauty of the material and its possibilities. Also discussion. 5000 w. Can Arch—Feb., 1899. No. 26277 C.

HEATING AND VENTILATION.

Centralized Plant.

The Centralized Heating and Power Plant of the Indiana University, Bloomington, Ind. J. D. Hoffman. Illustrated description of the installation of a Webster low-pressure or vacuum system. 800 w. Heat & Ven—March, 1899. No. 26648.

Factories.

Carbon Dioxide. Percy Bean. Considers its relation to the humidifying and ventilation of weaving sheds. 2800 w. Bos Jour of Com—March 25, 1899. No. 26681.

Fans.

Investigations of a Blowing Fan. R. C. Carpenter. Read before the Am. Soc. of Heat and Ven. Engs. Reprinted from the Jan. issue, with additions by the author. A résumé of experiments conducted to determine the general laws applying to centrifugal blowers of the class represented by the experimental fan. 5500 w. Heat & Ven—Feb., 1899. No. 26268.

Literature Relating to Blowing Fans. R. C. Carpenter. Prepared for the Am. Soc. of Heat and Ven. Engs. A compilation of titles of various papers which have been published. 2000 w. Heat & Ven—Feb., 1899. No. 26269.

Some Experiments with Centrifugal Fans. William S. Monroe. Results of experiments made to test the ventilating

system of the Chicago Public Library. 2500 w. Dom Engng—March, 1899. No. 26636 C.

Special Regulation of Motor Driven Fans and Blowers. Alton D. Adams. Considers methods of speed regulation and their effect on the efficiency. 1000 w. Heat & Ven—March, 1899. No. 26649.

Greenhouses.

Heating Horticultural Glasshouses. Frederick Dye. Illustrates and describes methods in use in England. 1700 w. Heat & Ven—March, 1899. No. 26650.

Post-Offices.

Ventilation and Heating of Post-office, Amsterdam, Holland. Illustrated description of the heating of a new Dutch public building by direct hot-blast, except during the coldest weather, when direct steam radiation is used. 900 w. Eng Rec—March 11, 1899. No. 26482.

Report.

Proposed Changes in the Hall of the House of Representatives. A review of the official reports on ventilation and heating of the hall. 1800 w. Eng Rec—March 25, 1899. No. 26677.

School.

Some Engineering Features of a Boston School. Illustrated description of the plant in the Mayhew High School, which is noteworthy for the method of spraying water into the heated air. 1800 w. Eng Rec—March 25, 1899. No. 26676.

PLUMBING AND GASFITTING.

Gas Fitting.

Good Gas Fitting. Act and regulations issued by the Boston Board of Health. 1400 w. Dom Engng—March, 1899. No. 26635 C.

Public Baths.

Public Baths. A. Saxon Snell. Read before the London Archt. Assn. A detailed description of the various parts of the building, with brief survey of the general plan. Discussion. 11000 w. Builder—March 11, 1899. No. 26612 A.

Public Baths and Gymnasia in Boston. Some facts given by Hon. Josiah Quincy in an address before the People's Inst., New York. 900 w. Eng News—March 16, 1899. No. 26556.

Public Baths and Wash-Houses. A Hessell Tiltman. Views of a writer who has had many years' experience in the planning, erection and administration of such establishments. Ill. 14500 w. Jour Roy Inst of Brit Arch'ts—Feb. 11, 1899. No. 26539 F.

See Municipal Engineering, Miscellany.

MISCELLANY.

Acoustics.

Acoustics. W. C. Sabine. Discusses the acoustical problem of an auditorium, its various phases, and gives suggestions for the solution. 3900 w. Pro of Am Inst of Arch'ts—1898. No. 26486 H.

Notes on Acoustics in Architecture. Adolf Cluss. Reviews results obtained by scientists and architects, and the established laws and axioms of sound, etc. 4500 w. Pro of Am Inst of Arch'ts—1898. No. 26487 H.

Architects and Engineers.

General Practice in Regard to the Employment of Electrical, Heating and Sanitary Engineers. Notes the great changes in architecture during the last fifty years, and discusses the relation of engineering and the way to secure the best results in erecting buildings requiring an engineer as well as an architect. 8000 w. Pro of Am Inst of Arch'ts—1898. No. 26488 H.

Iron Protection.

See Civil Engineering, Miscellany.

Terra-Cotta.

Terra-Cotta. Roger Smith. An interesting review of the use of terra-cotta both for purposes of ornament and building, with information concerning its manufacture, quality, etc. 7000 w. Builder—March 4, 1899. No. 26518 A.

CIVIL ENGINEERING

BRIDGES.

Aqueduct.

The Briare Aqueduct Bridge over the Loirè. (Le Pont-Canal de Briare sur la Loirè.) A very complete description of this important steel-tank canal-aqueduct bridge, with map, profiles and other illustrations. 3000 w. 1 plate. Génie Civil—March 11, 1899. No. 26706 D.

Arch.

The Elastic Arch. (Sur la Voûte Elastique.) Georges Poisson. A mathematical discussion of a particular case of the hydrostatic arch, considered in the light of the elastic theory. 1200 w. Comptes Rendus—Feb. 13, 1899. No. 26744 D.

The Merits and Permanency of the Masonry Arch Bridge. Albert W. Buel. With many handsome illustrations of masonry arches of various periods and countries, including a number of applications of reinforced concrete. 4000 w. Engineering Magazine—April, 1899. No. 26817 B.

Some Notable German Arch Bridges. Illustrated descriptions of some of the longest and, architecturally, most beau-

tiful bridges. 1100 w. Sci Am—March 25, 1899. No. 26638.

Competition.

Competition for Three Highway Bridges over the Flonthal at Lausanne. (Der Wettbewerb für drei Strassenbrücken über das Flonthal in Lausanne.) With illustrations of the premiated designs, and the report of the judges. Serial. Part 1. 2500 w. Schweizerische Bauzeitung—Feb. 25, 1899. No. 26749 B.

Concrete Arch.

Building a Concrete Arch. Series of views and detailed description of a good specimen of this class of work on the Erie & Pittsburg Div. of the Pennsylvania R. R. 1500 w. Ry Age—March 3, 1899. No. 26408.

Congo.

The Inkissi Bridge, Congo Railway. Illustrates and describes the erection of this bridge, which was attended with great difficulty. 1100 w. Engr, Lond—March 3, 1899. No. 26528 A.

Drawbridge.

Rebuilding of the Kinzie Street Drawbridge of the Chicago & Northwestern Ry. William H. Finley. Brief history of the old structure and illustrated description of the new. Discussion. 8000 w. Jour W Soc of Engs—Feb., 1899. No. 26832 D.

Floating Bridge.

The Floating Bridge at Lynn. C. J. H. Woodbury. An account of a unique wood bridge, built in 1803, which is still in use. It is essentially a very thick raft. 2000 w. Eng Rec—March 11, 1899. No. 26478.

Loads.

General Criterion for Position of Loads Causing Maximum Stress in Any Member of a Bridge Truss. L. M. Hoskins. A contribution toward the unification of the theory of maximum stresses due to moving loads. 6500 w. Pro Am Soc of Civ Engs—March, 1899. No. 26662 E.

Melan Arch.

Three-Span Melan Arch Bridge Across the Passaic River, Paterson, N. J. Brief illustrated description. 600 w. Eng News—March 16, 1899. No. 26557.

Paint.

Tests of Bridge Paint. Ira O. Baker. A summary of experiments. 1200 w. R R Gaz—March 10, 1899. No. 26453.

Railroad Bridge.

Bridge 69, New York Division, Pennsylvania Railroad. Illustrated description of a double-track deck structure of 235 feet span, built for heavy express traffic. Gives details of connections and supports. 1000 w. Eng Rec—March 4, 1899. No. 26669.

Reinforced Concrete.

The X Bridge at Mans. (Le Pont en X au Mans.) A description of this peculiar double intersecting bridge, giving an excellent discussion of the principles of reinforced concrete construction, of which it is an excellent example. 10000 w. 1 plate. Revue Technique—Feb. 10, 1899. No. 26708 D.

See Architectural Engineering, Construction.

Renewal.

The Temperanceville Bridge. Illustrated description of a three-tress, double-track deck bridge with interesting details. 1000 w. Eng Rec—March 4, 1899. No. 26400.

Rhine Bridge.

The New Bonn Bridge over the Rhine. A beautiful structure, costing about $1,000,000 is illustrated and described. 800 w. Sci Am Sup—March 11, 1899. No. 26435.

Swing Bridge.

Chicago, Madison & Northern Swing Bridge Over Drainage Canal. Brief illustrated description of the longest and one of the largest bridges which will span this canal. 700 w. Ry & Engng Rev—March 4, 1899. No. 26413.

Trestles.

The Iron Trestle Bridges on the Waidhofen-Gaming Railway (Die Eiserne Gerüstbrücken der Localbahn Waidhofen-Gaming.) Oskar Meltzer. A description of some modern trestle railway bridges on an Austrian local road, with photographs and illustrations of details. 2500 w. Zeit d Oesterr Ing u Arch Ver—Feb. 24, 1899. No. 26731 B.

Trestle Bridge, Esquimalt and Nanaimo Railway, British Columbia. Sketch of trestle bridge, on a curve, with a grade, designed by J. A. L. Waddell. 700 w. Ind Engng—Feb. 4, 1899. No. 26429 D.

Trusses.

Notes on the Statics of Double-Braced Trusses (Beitrag zum Statisch Bestimmten Gegliederten Balkenträger mit Zweifachem Ausfüllsystem.) W. Dietz. An examination of various forms of framed structures, using the graphical treatment, including cantilevers, swing bridges, and arches. 2500 w. Zeit d Ver Deutscher Ing—March 4, 1899. No. 26726 D.

Vauxhall Bridge.

The New Vauxhall Bridge. A letter, signed by men of prominence, protesting against the design of this structure and urging the coöperation of competent architects; also the answer of the chairman of the Bridges Committee, and editorial. 3000 w. Builder—March 11, 1899. No. 26611 A.

CANALS, RIVERS AND HARBORS.

Docks.

Developments at Penarth Dock. Brief account of the work the Taff Vale Railway Co. is undertaking at this place. 1300 w. Engr, Lond—March 10, 1899. No. 26601 A.

Dry Docks—Stone vs. Wood. An informal discussion of this subject at a special meeting of the society. 18000 w. Pro Am Soc of Civ Engs—March, 1899. No. 26663 E.

Floods.

Flood Forecasts. (La Prévision des Crues.) A very thorough discussion of the relations between rainfall and the rise of rivers, showing how the floods in certain rivers of France are predicted in advance; together with a discussion of the methods used in other countries. 5000 w. Revue Technique—Feb. 10, 1899. No. 26709 D.

Flow of Water.

The Character of Fluid Motion. Illustrated review of experiments by Prof. H. S. Hele-Shaw, showing the stream lines in flowing water. 1900 w. Eng Rec—March 4, 1899. No. 26398.

Isthmian Canals.

The Appointment of a Commission to Investigate Isthmian Canal Routes. Editorial criticism of the reported reappointment of the Walker Commission. 2700 w. Eng News—March 23, 189. No. 26643.

Manchester.

The Manchester Ship Canal. Elmer L. Corthell. Discusses the reasons for constructing this canal, and describes this great work and the results. Ill. 3000 w. Jour W Soc of Engs—Feb., 1899. No. 26830 D.

N. Y. State Canals.

The Canals of the State of New York. Editorial comment on the appointment, by the Governor, of a special commission to investigate the policy of the state toward its canals. 800 w. R R Gaz—March 17, 1899. No. 26565.

Nicaragua Canal.

The Nicaragua Canal. Lewis M. Haupt. Digest of a lecture delivered before the Friends' Inst. Lyceum, Philadelphia. Briefly reviews the history of this project, discusses the objections urged, and the advantages claimed, and the commercial aspect. Ill. 2800 w. Sci Am Sup—April 1, 1899. No. 26828.

The Nicaragua Canal. Brief discussion of the project as it now appears, of the effect on trade routes, and the desirability of an Anglo-American understanding. 1700 w. Engng—Feb. 17, 1899. No. 26219 A.

Ottawa Valley.

The Montreal, Ottawa and Georgian Bay Canal. A summary of the leading arguments given in a paper by Henry K. Wicksteed before the Can. Soc. of Civ. Engs. 1300 w. Can Engr—March, 1899. No. 26544.

Soulanges.

The Soulanges Canal. Thomas Monro. Describes this canal and calls attention to the many essential features in which it differs in design from the other links of the St. Lawrence system. 12000 w. Can Engr—March, 1899. No. 26542.

Stettin.

The New Harbour Works at Stettin. (Die Neue Hafenanlagen in Stettin.) W. Zimmermann. A description of the important dock and canal construction works recently completed at Stettin, costing more than 12 million marks. 3000 w. 1 plate. Glasers Annalen—March 15, 1899. No. 26736 D.

IRRIGATION.

Drainage.

Immense Drainage Project. Richard H. Edmonds. An account of an irrigation development in the Arkansas river valley, in Prowers Co., Colorado, through the enterprise of New York capitalists. 3000 w. Mfrs Rec—March 3, 1899. No. 26336.

Montrose Canal.

The Montrose Irrigation Canal, Colorado. W. P. Hardesty. Illustrated description of features of interest of a canal which irrigates about 6000 acres. 2200 w. Eng News—March 23, 1899. No. 26641.

MISCELLANY.

Beams.

Bending Moments in Simple Beams Due to Wheel Loads. Thomas J. Brereton. The paper derives a formula for maximum bending moments due to non-uniform loads, and illustrates some of its uses. Ill. 2000 w. Sch of Mines Quar—Jan., 1899. No. 26589 D.

The Position of the Neutral Axis in Stone and Iron Beams. (Der Lage der Neutralen Achse im Gebogenen Balken aus Stein und aus Gusseisen.) E. Roser. A review of existing experiments by Barlow, Navier and Föppl, with a discussion of the results in the light of the elastic theory. 3500 w. Zeit d Ver Deutscher Ing—Feb. 25, 1899. No. 26725 D.

Bids.

The Right to Withdraw Erroneous Bids. Full text of a decision by the United States Circuit Court of Appeals in the case of Moffett, Hodgkins & Clarke Co. v. City of Rochester, which refuses to allow a contractor to withdraw a bid on the ground of mistake in the figures. 4500 w. Eng Rec—March 4, 1899. No. 26402.

Cement.

Silica Portland Cement. M. J. Butler. On the manufacture of this product, its

adaptability to certain uses, testing, etc. 1600 w. Can Engr—March, 1899. No. 26543.

Specifications for Portland Cement. Review of novel requirements for both slow and quick-setting cement for a large hydaulic power station. 1600 w. Eng Rec—March 11, 1899. No. 26479.

Cement Testing.

Comparative Tests on Different Forms of Cement Briquettes. Jerome Sondericker. Describes the manner of testing and discusses the conditions which should be considered in standard methods, as determined by results. 3000 w. Jour Assn of Engng Soc's—Jan., 1899. No. 26331 C.

Foundations.

See Architectural Engineering, Construction.

Hydraulic Laboratory.

The Cornell Hydraulic Laboratory. J. H. Massie. Illustrated description of the reservoir, canal, penstock and laboratory proper, and a review of the proposed work to be done there. 3600 w. Eng Rec—March 4, 1899. No. 26399.

The Hydraulic Experiment Station of Cornell University. Information concerning the plant for making hydraulic experiments. Ill. 4800 w. Eng News—March 2, 1899. No. 26342.

Iron Protection.

Preservative Paints for Iron Chemically Considered. Explains the chemical nature and reaction of a simple red lead and red oxide of iron paint, so that the cause of incipient oxidation of the iron beneath the surface may be understood. 4000 w. Engng—Feb. 24, 1899. No. 26366 A.

Landslide.

The Landslide Disaster at Klappai in Bohemia. (Die Bergsturz Katastrophe bei Klappai in Böhmen). K. Kress. With photographs and a topographical map showing the nature of the disturbance, together with the engineering works for the prevention of a recurrence of the disaster. 3500 w. 2 plates. Oester Monastschr f d Oeffent Baudienst—March, 1899. No. 26747 D.

Models.

The Use of Models in Engineering. Shows the use of models in giving information and gives examples of fine works illustrating bridges, aqueducts, canals, and works in mining and metallurgy. 1800 w. Engr., Lond.—Feb. 24, 1899. No. 26375 A.

Road Construction.

The Massachusetts State Highway Report for 1898. Explains the reasons for the extra cost of the Massachusetts state roads as compared with those in New Jersey and gives an account of the methods of repairing roads which have proved most satisfactory. 3000 w. Eng Rec—March 25, 1898. No. 26671.

Topography.

The Application of Photography to the Production of Topographical Maps in Canada. (Sur de Nouvelles et Importantes Applications Faites au Canada de la Methode du Lever des Plans à l'Aide de la Photographie.) A. Laussedat. A communication to the French Academy upon the recent applications of photography to topographical surveying in Canada. 1800 w. Comptes Rendus—Feb. 27, 1899. No. 26745 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

See Measurement.

Coast Telegraphing.

Coast Telegraphic Communication. Charles Bright. Part first gives a review of the operations thus far carried out. 1800 w. Engr., Lond—Feb. 17, 1899. Serial 1st part. No. 26212 A.

Mine Signalling.

Electrical Communication in Mining Operations. W. E. Culbertson. A description of an installment by the D., L. & W. R. R. Co. for connecting the engine-room with the various slopes, shafts and veins. Ill. 2400 w. Mines & Min—March, 1899. No. 26391 C.

Electric Signals for Mine Hoists. (Elektrische Förderschalensignal Vorrichtung) K. Dekanovsky. By using the hoisting rope in connection with a fixed conductor, a bell or telephone signal communication is maintained with the car at all times. 1200 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 18, 1899. No. 26753 B.

Electrical Signalling Appliance for Cages. K. Dekanovsky in *Oesterreichische Zeitschrift für Berg und Hüttenwesen* Illustrated description of the device. 1100 w. Col Guard—Feb. 24, 1899. No. 26361 A.

Multiplex.

Multiplex Telegraphs. Editorial on the value of multiplex principle to railroad service. Does not think it likely to be generally used for some time to come. 800 w. R R Gaz—March 17, 1899. No. 26564.

Newark, N. J.

Central-Office System of the Newark Telephone Co. Illustrates and describes the stations and operation of the system. 900 w. W Elect'n—March 11, 1899. No. 26507.

Printing Telegraph.

Successful Trial of the Rowland Multiplex Printing Telegraph. Between Philadelphia and Jersey City. Illustrates this apparatus, stating the advantages of the system. 1000 w. Elec Eng, N. Y—March 2, 1899. No. 26316.

Repeaters.

New Telephone Repeater. James Asher. Describes the writer's method of combining Edison's loud-speaker with a carbon or other transmitter to produce loud speech at the end of a second circuit, or of an indefinite number of circuits. 1800 w. Elec Rev, N. Y.—March 15, 1899. No. 26540.

Space Telegraphy.

Various Forms of Detectors for Magnetic Space Telegraphy. Dr. Oliver Lodge. Abstract of a paper read before the Inst. of Elec. Engs. Illustrates and describes a number of devices. 1800 w. Elec Eng, N. Y.—March 2, 1899. No. 26315.

Wireless Telegraphy. G. Marconi. Read before the Inst. of Elec. Engs., England. Describes a series of very successful experiments with the writer's system, and calls attention to the importance of this method in naval and military operations. Ill. 6700 w. Ind & Ir—March 10, 1899. No. 26593 A.

Stock Reporting.

The Rise of the Stock Reporting Telegraph. Ralph W. Pope. Gives the history of the gold indicator, and stock reporting; the instruments used and by whom invented, and facts of interest in this connection. 3000 w. Elec Wld—March 2, 1899. No. 26320.

Submarine.

Submarine Telegraphs. Remarks on the submarine telegraphs of the world, and the practicability of a line across the Pacific. 1600 w. Bos Jour of Com—March 11, 1899. No. 26501.

The Developments of the Submarine Telegraph. From a statement prepared by the Treasury Bureau of Statistics, giving an outline of the history and the part America has had in the development. 1800 w. Arch & Build—March 11, 1899. No. 26464.

DISTRIBUTION.

Converters.

Action and Tension Available at the Brushes of a Converter. (Fonctionnement et Tension Disponible aux Balais d'une Commutatrice.) M. Aliamet. A study of the action of rotary converters, and the various methods of transforming currents possible by their use. 1500 w. L'Electricien—Feb. 25, 1899. No. 26773 B.

Insulation.

Insulation Measurements in Three-wire Circuits with Insulated Middle Wire. (Isolationsmessungen au Dreileiteranlagen mit Isolirtern Mittelleiter.) Dr. J. Kollert. The method is described, and an example in its application fully worked out. 1200 w. Elektrotech Zeitschr—March 2, 1899. No. 26768 B.

Interrupter.

Observations on the Wehnelt Interrupter. George T. Hanchett and Charles T. Child. Describes experimental reseaches by the writers with the view of determining the best form to be given the interrupter and how it might best serve the purpose for which it was intended. States conclusions. Ill.. 2000 w. Elec Wld & Elec Eng—March 25, 1899. No. 26651.

The Use of the Wehnelt Interrupter. Louis S. Levy. Gives results obtained in using the interrupter, stating the comparative effects of the Wehnelt interrupter and the ordinary form of vibrator. 800 w. Elec Wld & Elec Eng—March 25, 1899. No. 26652.

The Wehnelt Electrolytic Current Interrupter. Elihu Thomson. Reports experiments made by the writer with this interrupter for use with induction coils and the remarkable results. Ill. 200 w. Elec Eng. N Y—March 2, 1899. No. 26313.

The Wehnelt Electrolytic Interrupter. Elihu Thomson. Observations recently made on this interrupter, the applications and methods of working. 1400 w. Elec Wld & Elec Eng—March 18, 1899. No. 26581.

Rotary Equalizer.

Practical Applications of the Rotary Equalizer. Charles B. Davey. Gives applications of this device by means of which the potentials between the two sides of a three-wire system is maintained at a balance. 1700 w. W Elect'n—March 18, 1899. No. 26630.

Three-Wire System.

Saving by the Three-Wire System. Alton D. Adams. Shows that for a given number of lamps equal energy is lost in the two-wire and three-wire systems, and that the weight of conductors is only one-fourth as great for the three-wire as for the two-wire system. 1300 w. Am Elect'n —March, 1899. No. 26496.

Wiring.

Electric Wiring Rules. Editorial on the papers of R. E. B. Crompton, C. H. Wordingham, and J. Pigg, presented and discussed at a recent meeting of the Brit. Inst. of Elec. Engs. 2500 w. Engng—Feb. 17, 1899. No. 26221 A.

Modern Systems of Interior Wiring. L.

B. Chubbuck. Read before the Engng. Soc. of the School of Prac. Science, Toronto. Reviews the methods of wiring used since the introduction of electric lighting, and describes the systems in use at present. Ill. 4500 w. Can Elec News—March, 1899. No. 26570.

ELECTRO-CHEMISTRY.

Accumulators.

Accumulators for Electric Automobiles of the Société Anonyme Pour le Travail Electrique des Métaux. Describes a storage battery specially devised with reference to the requirements of the electric cab. 600 w. Elec Rev, Lond—Feb. 24. 1899. No. 26379 A.

Gas Electric Accumulators. (Les Accumulateurs Electriques à Gaz.) Max de Nansouty. A discussion of the Cailletet and Collardeau gas battery, using the electrolysed gases of liquids other than water, and at pressures of more than 500 atmospheres. 1800 w. L'Electricien—March 11, 1899. No. 26776 B.

Electric Smelting.

The Electrolytic Winning of Metals Direct from the Ore. (Elektrolytische Gewinnung von Metallen Direkt aus Erzen.) Dr. W. Borchers. A discussion of the recent paper of Dr. Höpfner, criticising details, but confirming the practicability of the processes. 1500 w. Zeitschr f Elektrochemie—March 2, 1899. No. 26780 G.

Electrolysis.

Experiment in Electrolysis Without Electrodes. (Experiment über Elektrolytische Leitung ohne Elektroden.) Dr. Behn-Eschenburg. A non-conducting trough containing the electrolyte is fitted around the iron core of a transformer, and a current is induced in the liquid. 1200 w. Zeitschr f Elektrochemie—March 2, 1899. No. 26779 G.

Electro-Metallurgy.

Recent Progress in Electrometallurgy. (Ueber die Neueren Fortschritte der Elektrometallurgie.) E. Andreoli. A general review of work in electrometallurgy on the continent as well as in the United States and England. 2000 w. Elektrochemische Zeitschr—March 1. 1899. No. 26781 G.

Nickel Plating.

Apparatus for Nickel Plating Numerous Small Objects at a Time. From *Revue Industrielle.* Calls attention to the great care necessary in preparing the objects, and describes the arrangements employed for the immersion in the bath. Ill. 1200 w. Sci Am Sup—March 4, 1899. No. 26293.

Vanadium.

A Note on the Electro-Deposition of Vanadium. Sherard Cowper-Coles. Where found, prices, etc., with some of its characteristics. 500 w. Elec Rev, Lond—Feb. 17, 1899. No. 26231 A.

ELECTRO-PHYSICS.

Alternating Currents.

Alternating Currents Twenty-five Years Ago, and To-day. Edwin J. Houston and A. E. Kennelly. The changes in the application and use of alternating currents are reviewed. 2200 w. Elec Wld—March 4, 1899. No. 26319.

Cathode Rays.

The Reflection of Cathode Rays. A. A. Campbell Swinton. Abstract of a paper communicated to the Royal Soc. Investigations which show that the field of reflected cathode rays is not uniform, but increases on both sides to a maximum. 600 w. Elec Eng, Lond—March 3, 1899. No. 26513 A.

Currents.

Some Experiments in Tesla's Laboratory with Currents of High Potential and High Frequency. Nikola Tesla. Illustrated description. 4000 w. Elec Rev, N. Y.—March 29, 1899. No. 26825.

Generation.

Electricity Generated Direct from Coal. (L'Electricité Obtenue Directement par Combustion du Charbon.) E. Lievenie. A review of the various methods which have been proposed since the time of Becquerel in 1855. 1500 w. Revue Technique—Feb. 25, 1899. No. 26711 D.

GENERATING STATIONS.

Armatures.

On the Dimensioning of Armatures. George T. Hanchett. The effect of lengthening the drum armature is discussed, showing that in general long armatures are to be avoided. 1500 w. Elec Wld & Elec Eng—March 11, 1899. No. 26472.

The Theory of Armature Windings. (Beitrag zur Theorie der Ankerwickelungen.) Ch. Westphal. A brief mathematical discussion, with especial reference to continuous current dynamos. 1200 w. Elektrotech Zeitschr—Feb. 9, 1899. No. 26759 B.

Bankside Station.

The City of London Electric Lighting Company. Part first gives an illustrated general description of the Bankside station, which is said to be the largest station for lighting purposes in the world. 2800 w. Engr, Lond—March 10, 1899. Serial. 1st part. No. 26602 A.

Boston, Mass.

The Isolated Plant of the New Boston Railway Terminal. H. W. Weller. Illustrated description of the power plant for the heat, light and ventilation, the operation of elevators, supply of hot and cold

water, making ice, pumping, electro-pneumatic switching, and signaling. 6600 w. Elec Wld & Elec Eng—March 11, 1899. No. 26471.

Brazil.

Electric Light and Power Plant at Para, Brazil. An illustrated description of the plant, and some of the difficulties encountered in a tropical country. 3500 w. Elec Eng, N. Y.—March 2, 1899. No. 26314.

City of London.

The City of London Electric Lighting Company's Works. A brief account of the formation of the company and illustrated description of some of the details. 1800 w. Elec Rev, Lond—March 3, 1899. Serial. 1st part. No. 26515 A.

Converters.

Rotary Converters. (Les Convertisseurs Rotatifs.) A discussion of the construction and action of the rotary converter, with illustrations of various designs. 2500 w. Génie Civil—March 11, 1899. No. 26707 D.

Dynamos.

Dynamo and Engine Capacities. Alton D. Adams. On the importance of giving attention to combined operative efficiency under average working conditions. 1400 w. Engr. U. S. A.—March 1, 1899. No. 26410.

Electrical Things That Are Not What They Seem. Alton D. Adams. Critical review of the claims of a new electric generator recently advertised. 1200 w. Elec Wld & Elec Eng—March 18, 1899. No. 26583.

Signal-Current Generators for Telephone Exchanges. H. P. Clausen. Illustrates the generators and describes the operation. 2000 w. W Elect'n—March 4, 1899. No. 26424.

Equalizing.

Two-Rate Charging from the Consumer's Standpoint. Lyman C. Reed. Thinks the system very unsatisfactory, and that the question is solved by the use of accumulators, thus doing way with the excessive engine peak at certain hours. 1300 w. Am Elect'n—March, 1899. No. 26497.

Fuse.

The Electric Fuse. Alton D. Adams. Describes the electric fuse and the advantages gained through its use. 1000 w. Sci Am—March 4, 1899. No. 26291.

High Wycombe.

High Wycombe Electricity Works. Illustrates and describes this installation. 4800 w. Elec Eng, Lond—March 3, 1899. No. 26512 A.

Lincoln, England.

Lincoln Corporation Electric Supply Works. Illustrated detailed description. 1800 w. Elect'n, Lond—March 3, 1899. No. 26516 A.

New York City.

Foundations and Chimney for 45,000-H.P. Electric Power Station, Metropolitan Street Railway Co., New York City. Illustrated description of the details of the chimney and foundations of one of the two largest power stations in the world. 1800 w. Eng News—March 2, 1899. No. 26345.

Oscillation.

The Oscillation of Parallel Connected Dynamos. (Das Pendeln Paralell Geschalteter Maschinen). Gisbert Kapp. A discussion of the best methods of preventing the oscillations which sometimes appear in direct-driven dynamos which are connected in parallel. 4000 w. Elektrotech Zeitschr—Feb. 16, 1899. No. 26761 B.

South Africa.

The Electric Power Plant at Johannesburg. Die (Elektrische Kraftübertragungsanlage bei Johannesburg.) Walter Klug. A description of the large plant of the Rand Central Electric Works, which supplies light and power to the mines of the district. 6000 w. Glückauf—Feb. 18, 1899. No. 26751 B.

Sparking.

The Limit of Load Without Sparking. (La Limite de la Marche sans Etincelles.) A mathematical discussion of the cause of sparking in continuous current dynamos, showing the conditions under which a minimum degree of sparking may be secured. 2000 w. Revue Technique—Feb. 25, 1899. No. 26710 D.

The Limits of Sparking With Continuous-Current Dynamos. Gisbert Kapp. Abstract translation from *Elektrotechnische Zeitschrift*. A generally applicable formula, based on scientific reasoning, is given, so simple as to admit of its employment by practical men. 2500 w. Elec Eng, Lond—Feb. 17, 1899. No. 26233 A.

Switches.

Circuit Breakers and Interrupters (Coupe-Circuits a Interrupteurs.) A general discussion by various members of the society, with a view of unifying construction and establishing standards. Two papers. 10000 w. Bull de la Soc Int des Electriciens—Jan., Feb., 1899. No. 26771 each F.

Double Switch System for Accumulators. (Doppelzellenschalter für Akkumulatoren.) H. Müller. A description of the switch and distribution system used in connection with the accumulators at the power house at Barmen, Germany. 1500 w. Elektrotech Zeitschr—Feb, 23, 1899. No. 26763 B.

Transformer.

A Discussion of the Operation of the Alternating-Current Transformer. (Uber Auffassung und Darstellung der Vorgänge im Wechselstromtransformator.) Dr. C. Heinke. A very thorough mathematical treatment, using both graphical and analytical methods. Three articles, 12,000 w. Elektrotech Zeitschr—Mar. 2, 9, 16, 1899. No. 26766 each B.

Tyrol.

The Electric Plants in the Tyrol, the Voralberg and Trent. (Le Officine Elettriche nel Tirolo e Voralberge nel Trentino.) E. Lanzerotti. A general review of the development of the power of the Tyrolese Alps and its electrical distribution. 2000 w. L'Elettricita—March 4, 1899. No. 26794 B.

HEATING AND WELDING.

Warming.

The Le Roy Process for Warming by Electricity. (Le Chauffage Electrique par les Buches Le Roy.) An illustrated description of this improved apparatus. The heat is produced by passing the current through rods of silicon in vacuum tubes. Radiators and other applications are shown. 800 w. L'Electrician—Feb. 25, 1899. No. 26772 B.

Welding Transformer.

Miscellaneous Shop Uses of the Welding Transformer. George T. Hanchett. Notes briefly some of the applications. 700 w. Am Mach—March 23, 1899. No. 26665.

LIGHTING.

Arcs.

Series Arc Lighting. W. H. Turbayne. Read before the C. A. S. E. An explanation of the principles involved, with a short description of the functions of the mechanisms employed in a modern system in which a direct current of constant value is employed. 1800 w. Can Engr—March, 1899. No. 26545.

Canterbury.

Canterbury Electric Light Works. Illustrated detailed description. 4000 w. Elec Eng, Lond—March 10, 1899. No. 26616 A.

Cost.

Cost of Electric Light. Alton D. Adams. Considers some of the reasons for difference in cost as compared with gas, and the ways in which the charge is regulated. 1000 w. Sci Am—March 11, 1899. No. 26432.

Incandescent Lamps.

The Difference Between Good and Bad Incandescent Lamps. Francis W. Willcox. On the means of distinguishing between good and bad lamps, with a short account of the Standard Oil Co.'s lamp test. 4000 w. Elec Wld & Elec Eng—March 18, 1899. No. 26582.

Nernst Lamp.

Forerunners of the Nernst Lamp. Calls attention to other workers in this field who have apparently anticipated this invention. 2500 w. Elec. Rev, Lond—Feb. 24, 1899. No. 26380 A.

Nernst Lamp v. the Arc and Incandescence Lamps. John I. Hall. Part first gives attention to the cost and concludes in this matter at least the Nernst lamp has not the advantage. 1200 w. Elec Rev, Lond—March 17, 1899. Serial. 1st part. No. 26801 A.

The Incandescence of Refractory Electrolytes. Editorial discussion of Prof. Nernst's invention, and of the neglected discoveries which anticipated it. Ill. 2800 w. Engng—March 3, 1899. No. 26523 A.

Report.

The Growth of Electric Lighting in New York City. Data from the annual report of R. R. Bowker, relating to the work of the corporation to date and its plans for the future. Ill. 2000 w. Elec Wld & Elec Eng—March 18, 1899. No. 26580.

MEASUREMENT.

Cables.

The Determination of the Electrical Capacity of Telephone Cables with Double Conductors. (Ueber die Bestimmung der Elektrischen Kapacität von Fernsprechkabeln mit Doppelleitungen.) F. Breisig. A mathematical discussion of the practical methods used by the Imperial postal telegraph system. 6000 w. Elektrotech Zeitschr—Feb. 9, 1899. No. 26760 B.

Conductors.

Tests of Conductors for 10,000 volts. (10,000 V-Kabelversuche.) A. Hassold. Tabulated data and results of tests made on the long-distance transmission between Bozen and Meran, Austria. 1800 w. Elektrotech Zeitschr—March 9, 1899. No. 26769 B.

Hysteresis.

The Blondel-Carpentier Hysteresis Meter. (Der Hysteresismesser Blondel-Carpentier.) A brief description, with illustrations. The principle is the same as that of the Ewing rotary hysteresis meter. 800 w. Elektrotech Zeitschr—March 2, 1899. No. 26767 B.

Measurement.

Measurements on Telephone Conductors. (Messungen an Fernsprechverbindungesleitungen.) F. Breisig. A mathematical discussion of the method used on the Berlin telephone system; employing alternating currents. 5000 w. Elektrotech Zeitschr—March 9, 1899. No. 26770 B.

Meter Testing.

Meter Testing and Handling. James E.

Judd. Illustrates and describes the method and equipment of a testing department. 900 w. Am Elect'n—March, 1899. No. 26494.

Stray Currents.

A System for the Control of Stray Currents of Electric Tramways. (System zur Kontrolle der Vagabondirenden Ströme Elektrischer Bahnen.) Dr. M. Kallmann. Mainly devoted to methods of measuring stray currents; comparing German and American practice. 10,000 w. Elektrotech Zeitschr—Feb. 23, 1899. No. 26765 B.

POWER APPLICATIONS.

Agriculture.

The Electric Lighting and Power Plant on the Lancken Estate. (Elektrische Beleuchtungs und Kraftübertragungsanlage auf dem Rittergut Lancken.) An illustrated account of a complete agricultural plant on a large estate in Rügen, Prussia, showing numerous applications of electric power to agricultural work. 1200 w. Elektrizität— March 4, 1899. No. 26782 B.

Electric Cabs.

See Mechanical Engineering, Automobilism.

Electric Locomotives.

See Railway Affairs, Motive Power.

Italian Navy.

See Military Engineering.

Lift.

Passenger Lift Equipment for the Central London Railway. States the general conditions for the tenders of these elevators, with an illustrated description of the equipment, which is of American design and make. 1400 w. Engng—March 3, 1899. Serial. 1st part. No. 26519 A.

Marine Auxiliaries.

Electricity on Board Ship. S. Dana Greene. Considers principally the application to war vessels, but is equally applicable to merchant marine. Also discussion. 17500 w. Trans Am Inst of Elec Engs—Jan. 1899. No. 26661 D.

Motor.

How to Make a Sewing Machine Motor Without Castings. Cecil P. Poole. Drawings and instructions for building an efficient motor that will operate the heaviest family sewing machine with a consumption of electrical energy only slightly greater than that required for an incandescent lamp. 5500 w. Sci Am Sup—March 11, 1899. No. 26433.

Motor Design.

Design of a ¼ H. P. Single-Phase Induction Motor. P. M. Heldt. Describes a motor designed to be built by amateurs. 2700 w. Am Elect'n—March, 1899. No. 26405.

Power Station.

See Street and Electric Tramways.

Printing.

Electricity in Printing, Binding and Engraving. Illustrates and describes special applications of the electric motor. 2500 w. Am Elect'n—March, 1899. No. 26493.

Propulsion.

Electric Propulsion for Torpedo Boats. (La Propulsion des Torpilleurs par l'Electricité). George Davy. An extended review of a recent paper by C. T. Child on this subject. 1800 w. L'Electricien—March 18, 1899. No. 26795 B.

Electric Propulsion for Torpedo Boats. W. F. Durand. A criticism of C. T. Child's article on the same subject giving many data and arguing that the present limitations of electrical application prevent the use of battery-driven boats. 6000 w. Jour Am Soc of Naval Engs—Feb., 1899. No. 26491 H.

Pumps.

Electric Pumps and Pumping. A. W. K. Pierce. Deals with the disposal of underground water in mining, assuming that electric pumps are to be used; discusses the type, the system of transmission, apparatus, size, capacity, etc. Ill. 4000 w. Ir & Coal Trds Rev—Feb 17, 1899. No. 26209 A.

Shop Practice.

See Mechanical Engineering, Machine Works and Foundries.

Speed.

The Stroboscopic Method of Determining the Speed of Small Motors. (Stroboskopische Methoden zur Bestimmung der Umdrehungszahle Kleiner Motoren.) G. Benischke. The speed is determined by viewing the fan driven by the motor to be tested through openings in a disk driven by another motor of known and controlled speed. 1800 w. Elektrotech Zeitschr—Feb. 16, 1899. No. 26762 B.

Wolverhampton.

The Electric Construction Company's Works at Wolverhampton. Gives a short history of the development and an illustrated description. 2800 w. Elect'n, Lond—March 10, 1899. No. 26617 A.

TRANSMISSION.

Address.

The Past, Present and Future of Electric Power Transmission. (Vergangenheit, Gegenwart, und Zukunft der Electrischen Kraftübertragung.) Josef Kareis. An interesting address delivered before the Technical Association of Lower Austria, giving a general review of the situation. Two articles. 3500 w. Electro-Techniker—Feb. 28, March 1, 1899. No. 26785 each B.

Conductors.

See Measurement.

High Voltage.

High Voltage Transmission. Editorial review of experiments made in America, and the paper of Charles F. Scott, read before the Am. Inst. of Elec. Engs. 2400 w. Engng—Feb. 24, 1899. No. 26367 A.

Insulation.

The Insulation of Overhead Electric Lines.(Insolement des Lignes Electriques Aériennes.) A. Fleury. A discussion of the relative merits of glass and porcelain, with methods of testing their behaviour in moist weather. 1800 w. L'Electricien—Feb. 25, 1899. No. 26774 B.

Long Distance.

Water-Power Plants with Long-Distance Electric Transmission in Southern California. C. E. Fowler. Introductory remarks on the extent of these plants, with illustrated description of that recently completed by the Southern California Power Co. 5000 w. Eng News—March 9, 1899. Serial. 1st part. No. 26443.

Three-Phase.

Three-Phase Transmission for Electric Railway Work in Maine. Describes the system of the Lewiston, Brunswick & Bath street railway. Ill. 1300 w. St Ry Jour—March, 1899. No. 26417 D.

MISCELLANY.

Atmospheric Electricity.

The Origin of Atmospheric Electricity. Prof. Cleveland Abbe, in the *U. S. Monthly Weather Review.* Notes the suggestions of many scientists, but considers the tests have given only negative results, and that the problem is still unsolved. 1400 w. Nature—March 9, 1899. No. 26615 A.

Education.

The Education of Electrical Apprentices and Journeymen. Arthur A. Hamerschlag. On the desirability of training young men to be efficient electrical workers. Discussion. 6400 w. Trans Am Inst Elec Engs—Jan., 1899. No. 26660 D.

Lightning Protection.

Approved Lightning Protection. Nevil Monroe Hopkins. On the historic and modern lightning-rod and its incorrect application. Ill. 3700 w. Sci Am Sup—March 25, 1899. No. 26640.

Symposium.

The Advantages and Disadvantages of the Electrical Profession. Extracts from the address and symposium presented at the meeting of the Electrical Club of the Young Men's Christian Ass'n, of Chicago. 4000 w. Elec Wld—March 4, 1899. No. 26318.

MARINE ENGINEERING

Collisions.

The Prevention of Collisions at Sea During Foggy Weather. Describes a system for the prevention of collisions at sea during foggy weather, which was invented by N. Bottone. 1400 w. Steamship—March, 1899. No. 26510 A.

Condenser.

Official Report on the Operation of Ericsson's Surface Condenser and Evaporator for Marine Engines—1847. Copy of a document interesting to naval engineers. 2500 w. Jour Am Soc of Naval Engs—Feb., 1899. No. 26492 H.

Corrosion.

The action of Sea Water Upon Copper Alloys. (Die Bestandigkeit der Gebrauchlichsten Kupferlegirungen im Seewasser.) A discussion of the experiments made by the German navy, upon the alloys most generally used for sheathing vessels. Two articles, 5000 w. Stahl und Eisen—Feb. 15, Mar. 1, 1899. No. 26739, each D.

Dredges.

High Powered Dredges and Their Relations to Sea and Inland Navigation. Lindon W. Bates. Part first considers the evolution of modern hydraulic dredging, various types of dredges and their characteristics. Ill. 5000 w. Naut Gaz—March 9, 1899. Serial. 1st part. No. 26463.

Fog.

Navigation in Foggy Weather. (Navigation en Temps de Brouillard.) E. Lacoine. A discussion of a system of signal stations, producing audible signals and forming a sort of block-system, for use in harbours and similar situations. 2000 w. Revue Technique—March 10, 1899. No. 26719 D.

Freeboard.

Some Considerations on Freeboard and on the Relation between Scantlings and Freeboard. Archibald Hogg. Read before the North East Coast Institution of Engineers and Shipbuilders. An investigation of the freeboard question, giving tables. 2300 w. Engs' Gaz—March, 1899. No. 26427 A.

Marine Auxiliaries.

See Electrical Engineering, Power Applications.

Marine Engines.

Engines of the S. S. "Ultonia." Two page plate, with description. 1300 w. Engng—March 3, 1899. No. 26520 A.

The Engines of H. M. S. Goliath. Illustrated description. 800 w. Engr, Lond—Feb. 24, 1899. No. 26376 A.

Mercantile Marine.

The Conditions of the German Mercantile Marine. Details from Mr. Gastrell's recent report on the commercial and maritime interests of Germany. Its mercantile marine is now the third largest in the world. 2800 w. Ir & Coal Trds Rev —March 3, 1899. No. 26532 A.

Raising.

Raising Sunken Vessels. From *La Nature*. Illustrates and describes the methods used in raising the "Rossia," in the river Neva, and the British ironclad, "Victorious," near Port Said. 1300 w. Sci Am—March 4, 1899. No. 26290.

Russia.

Some Notes in Russia. Deals with Russian dockyards. Part first discusses the New Admiralty Yard, St. Petersburg. Ill. 2200 w. Engr, Lond—Feb. 24, 1899. Serial. 1st part. No. 26373 A.

Ship-Building.

The Prospective Expansion of American Shipbuilding. G. R. Dunell. An examination of the coming American competition, showing that the command of the steel trade is the key to the control of the shipbuilding industry. 4500 w. Engineering Magazine—April, 1899. No. 26822 B.

Ship Lighting.

Consideration of the Voltage Used in Electric Ship Lighting. Alton D. Adams. Advises the 100-volt pressure as best suited for a ship's plant at the present time. 1000 w. Marine Engng—March, 1899. No. 26335 C.

Steamship.

New Oil-Carrying Steamship. Illustrated detailed description of the steel screw steamer Atlas. 4400 w. Naut Gaz —Feb. 23, 1899. Serial. 1st part. No. 26266.

The Ponce and the San Juan. Illustrated description of the two new steamships now under construction at the shipyard of the Harlan & Hollingsworth Co., for the Porto Rico trade. 1300 w. Naut Gaz—March 2, 1899. No. 26337.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Air Resistance.

Air Resistance to Moto Cars. H. E. Wimperis. Comments on the little known of this subject, and suggests methods of making experiments. 1500 w. Automotor Jour—Feb., 1899. No. 26264 A.

Commercial Operation.

The Motor Vehicle in Commercial Operation. G. Herbert Condict. Considers the electric motor the form of power presenting the least objectionable features, discusses the station, wheels, etc. 1800 w. Elec. N. Y.—March 1, 1899. No. 26294.

Contest.

The Boston (U. S. A.) Moto-Vehicle Contest. An account of the entries and the points considered, with extracts from the judges' report. 4000 w. Automotor Jour—Feb. 15, 1899. No. 26262 A.

Design.

Some New Features in Motor-Vehicle Design. Thomas H. Parker. Read before the Liverpool Self-propelled Traffic Assn. Describes the work of the writer in this field and the success attained. 2800 w. Ind & Ir—March 3, 1899. No. 26530 A.

Disaster.

The Harrow Moto-Car Accident. Description of the accident which caused the loss of two lives, and which is attributed to faulty design or imperfection in a wheel. Report of the inquest, letter, and discussion of the cause. 3300 w. Automotor Jour—March 15, 1899. No. 26697 A.

Driving-Wheels.

The Design of Driving-Wheels. A discussion of needed improvements in design to satisfy the requirements of safety and comfort. Suggested by the Harrow accident. 1200 w. Automotor Jour—March 1899. No. 26699 A.

Electric Cabs.

Electric Cabs in Paris. Remarks on the automobile cab competition held some time ago in France, with a description of the cabs of the Compagnie Générale. Ill. 2500 w. Engng—Feb. 24, 1899. Serial. 1st part. No. 26365 A.

Evolution.

The Evolution of the Motor-Car. E. Shrapnell Smith. Excerpt from a paper read before the Univ. College Students' Engng. Soc. Thinks the problems most pressing are to combine strength, lightness and efficiency and to secure sufficient adhesion on greasy surfaces. 1100 w. Automotor Jour—Feb., 1899. No. 26263 A.

Military Transport.

Automotors and Military Transport in Campaigns. M. de Capitaine Bardonnant in *La Revue du Cercle Militaire*. Abstract and criticism of an article by Major Mirandoli, published in the *Rivista di Artiglera e Genio*. 2000 w. Automotor Jour—March 15, 1899. No. 26695 A.

Steam.

The Application of Steam to Self-con-

tained Road Vehicles. Excerpt from a paper read before the Liverpool Self-propelled Traffic Essn., by W. Norris. Discusses the writer's view of the correct lines on which a successful steam motor-driven vehicle should be designed. 2500 w. Automotor Jour—Feb., 1899. No. 26265 A.

Tractor.

A Road Ring-Rail Tractor. Illustrated description of a German solution of the problem of diminishing resistance caused by uneven roads. 1200 w. Automotor Jour—March 15, 1899. No. 26696 A.

Tyres.

Pneumatic Tyres for Moto-Vehicles. S. F. Edge. Excerpt from a paper read before the Automobile Club. Considers cost, advantages and disadvantages. 2000 w. Automotor Jour—March 15, 1899. No. 26698 A.

HYDRAULIC ENGINEERING.

Centrifugal.

Centrifugal Pumps. W. H. Booth. On the work of these pumps, their speed, efficiency, etc. 3000 w. Am Mach—March 2, 1899. No. 26383.

The Present Status of the Centrifugal Pump. Henry P. Jones. Gives a study and comparison of collected data, discussing the class of pumps not built for particular conditions, but intended to satisfy the general demand. 2800 w. Eng News—March 9, 1899. No. 26447.

Italy.

Concessions for Hydraulic Power. (Le Concessioni di Forze Idrauliche.) A discussion of the quantity of hydraulic power available in Italy, and the probable cost of its electrical transmission to points of application; in view of the granting of concessions to undertakers for its development. Two articles, 3500 w. Rivista Gen d Ferrovie—Jan. 8, 15, 1899. No 26793, each B.

Power Development.

Early Development of Water Power in the United States. J. T. Fanning. Extract from a paper read at meeting of the Am. Pulp & Paper Assn. Review of the water power history and development, which began in early colonial times. 2500 w. Eng News—March 2, 1899. No. 26346.

Pumping Engines.

See Municipal Engineering, Water Supply.

Pumps.

See Steam Engineering.

Suction Pipes.

The Mechanics of Suction and Suction Pipes. Daniel W. Mead. Considers in detail the local conditions and mechanical arrangements which determine the height at which the pump cylinder may be set above the water level. 1200 w. Jour W Soc of Engs—Feb., 1899. No. 26831 D.

MACHINE WORKS AND FOUNDERIES.

Blowers.

The Relation of Velocity and Pressure in Centrifugal Blowers. Alton D. Adams. Investigations to find which of two statements is correct, and pointing out an error in Mr. Snell's formula. Also editorial discussion. Ill. 3200 w. Eng. News—March 9, 1899. No. 26444.

Boring.

A Large Special Horizontal Boring and Milling Machine—"Made in Germany." Half-tone and drawing showing an interesting machine built by Droop & Rein. Bielefeld, Germany. 500 w. Am Mach—March 9, 1899. No. 26421.

Chilled Rolls.

See Mining and Metallurgy, Iron and Steel.

Castings.

Coke and Charcoal Iron for Malleable Castings. Erastus C. Wheeler. Considers some of the comparable qualities in each iron, giving deductions gathered from experience. 2000 w. Ir Age—March 30, 1899. Serial, 1st part. No. 26826.

To Make Straight Castings. P. R. Ramp. Suggestions with illustrations. 500 w. Foundry—March, 1899. No. 26633.

Cast Iron.

Cast Iron. Dr. R. Moldenke. Considers chemical properties, the making, tests, etc. 2200 w. R R Gaz—March 10, 1899. No. 26457.

Cores.

Round Cores and Prints. From the *English Mechanic*. Remarks on the common round or square print fastened on the top and bottom faces of a pattern, to carry a vertical core. 2800 w. Prac Engr—Feb. 24, 1899. No. 26386 A.

Cranes.

Patterns for Crane Cheeks. Joseph Horner. Illustrates and describes methods of constructing. 1300 w. Am Mach—March 16, 1899. No. 26549.

Drill.

A Five-Spindle Drilling Attachment. A. H. Cleaves. An illustrated detailed description of the tool. 600 w. Am. Mach—March 2, 1899. No. 26382.

The Davis Calyx Drill. Illustrates and describes this drill and its achievements, stating the principal advantages. 1800 w. Col Guard—Feb. 17, 1899. No. 26226 A.

Fly Wheels.

Fly-wheel Explosions. (Ueber Schwungrad explosionen.) J. Goebel. A mathemacal examination on the centrifugal stresses tending to produce explosions of fly-wheels. 1500 w. Zeit d ver Deutscher Ing—March 4, 1899. No. 26727 D.

Gauges.

Wire Gauges. S. H. Stupakoff. Read before the German Engs.' Soc. at Pittsburg. Gives list of gauges in use, discussing their form and material, variations, advantages and disadvantages, etc. 2800 w. Ir Trd Rev—March 23, 1899. Serial. 1st part. No. 26647.

Hardening.

See Mining and Metallurgy, Iron and Steel.

Jigs.

Two Milling Jigs. A. H. Cleaves. Illustrates and describes two jigs, whose most important feature is said to be the facility they afford for taking a heavy cut with a small hold on the work. 800 w. Am Mach—March 9, 1899. No. 26420.

Machinery.

See Mining and Metallurgy, Miscellany.

Molding.

Molding a Road-Wheel in Loam. Joseph Horner. Illustrates and describes wheels made in this way to save the expense of making full patterns. 1200 w. Mech Wld—March 17, 1899. No. 26693 A.

Premium Plan.

Experience with the Premium Plan of Paying for Labor. F. A. Halsey. Outlines the plan which was described eight years ago, and presents data concerning its working in a well-known manufacturing corporation, which has had the plan on trial for two years, showing that it does what is claimed. 4000 w. Am Mach—March 9, 1899. No. 26419.

Some Questions Regarding the Premium Plan with Answers to Them. F. A. H. Discusses the applicability of the plan to stated conditions. 1800 w. Am Mach—March 23, 1899. No. 26666.

Printing Machinery.

Machinery for Book and General Printing. William Powrie. Read before the Inst. of Mech. Engs., England. Deals with the leading types of machines used for book and job printing. Ill. 3000 w. Engng—March 10, 1899. Serial. 1st part. No. 26598 A.

Rolling Mill.

See Mining and Metallurgy. Iron and Steel.

Rolls.

See Mining and Metallurgy, Iron and Steel.

Sheffield Works.

Victoria Works, Sheffield. Illustrates and describes an extension of these works for the manufacture of railway fittings. 3200 w. Engng. Feb. 17, 1899. No. 26218 A.

Shop Practice.

Electrical Shop Practice. B. F. Fells. Calls attention to slight repairs often needed in running electrical machinery. Ill. 1200 w. W Elect'n—Feb. 25, 1899. No. 26270.

Some Points of Practice Seen in the Shops of the Cincinnati Milling Machine Co. F. J. M. Describes an index worm-wheel testing machine, an arrangement of overhead rail for lathes, arrangement of rail and hoist for drill-presses, graduating machine, and machine for marking figures. Ill. 2500 w. Am Mach—March 16, 1899. No. 26550.

Shop Costs.

Depreciation as an Element of Machine-Shop Cost-Keeping. H. M. Norris. A discussion of the relation of depreciation to general expense, showing the various methods adopted in writing off plant and the use of cost diagrams. 4500 w. Engineering Magazine—April, 1899. No. 26820 B.

Slot Machines.

Coin-Controlled Machinery. Arthur F. Wines. Describes a device of the writer's invention which is intended for use in connection with automatic telephones, but applicable to other machines. Ill. 1500 w. Sib Jour of Engng—March, 1899. No. 26620 C.

Tool.

Turret Forming Tool. H. Goldsmith. Illustrates and describes this tool, considers why so called, and the variety of work to which it is applied. 800 w. Mach, N. Y.—March, 1899. No. 26284.

Tubing.

The Production of Ribbed Tubes and Poles. (Herstellung von Rippenrohren und Rohrmasten.) Otto Klatte. Describing a method of rolling seamless ribbed tubing from the ingot, for use as trolley poles, etc. 2000 w. Stahl und Eisen—March 1, 1899. No. 26740 D.

Wages.

Wages and Production. Arthur A. Fuller. A discussion of co-operative plans and their effect upon production. 2000 w. Mach, N. Y.—March, 1899. No. 26288.

Watch Industry.

The Building of a Watch. Illustrates and describes the construction and adjustment of the machine-made watch, as carried out at the Waltham Watch Factory. 4000 w. Sci Am—March 4, 1899. No. 26289.

Wheels.

How Metal Wheels Are Made. B. F. Spalding. On the increased use of metal wheels, their strength, durability and cheapness, with information concerning them. 2200 w. Am Mach—March 16, 1899. No. 26,551.

Wood-Working Machinery.

The Development of Woodworking Machinery. John Richards. Mr. Richards's

third paper discusses the special features of European sawing machinery, including gang saws, band saw mills and various forms of saw benches. 3500 w. Engineering Magazine—April, 1899. No. 26821 B.

Works Management.

Machine Shop Management in Europe and America. H. F. L. Orcutt. Mr. Orcutt's fourth paper discusses the differences in commercial methods and sales management between European and American establishments. 3500 w. Engineering Magazine—April, 1899. No. 26816 B.

MATERIALS OF CONSTRUCTION.

Alloys.

The Influence of Temperature on the Properties of Alloys. (Etude sur l' Influence de la Température sur les Propriétés des Alliages Métalliques.) M. G. Charpy. A very complete investigation of the effect of increased temperature upon the strength of alloys, with especial reference to various bronzes and copper alloys. 12000 w. Bull de la Société d' Encour—Feb., 1899. No. 26737 G.

Boiler Material.

Recent Advances in the Manufacture of High-Grade Boiler and Pipe Material. On the continual and rapid progress in materials, made necessary by increase of pressures. Ill. 5500 w. Jour Am Soc of Naval Engs—Feb., 1899. No. 26490 H.

Testing.

First Results of the A. F. A. Tests. A memorandum, from Dr. Richard Moldenke, chairman of the committee, relative to the first series of test bars and the results of the physical tests. Tables. 1000 w. Ir Trd Rev—March 9, 1899. No. 26439.

Testing Machines. F. A. Riehle. Read before the Foundrymen's Assn., at Philadelphia. Information concerning the extent to which testing of materials is now carried, and the use of testing machines. 3300 w. Ir Trd Rev—March 9, 1899. No. 26437.

The International Association for Testing Materials. Gus. C. Henning. A review of the origin and work of this important organization, showing its important relation, both to the manufacturing and the export engineering trades. 4000 w. Engineering Magazine—April, 1899. No. 26824 B.

POWER AND TRANSMISSION.

Dynamometer.

A New Hydraulic Dynamometer. (Nouveau Système de Dynamomètre à Pression Hydraulique.) The pressure on a thrust bearing or on the driving arms of a revolving coupling is transmitted hydraulically to a pressure gauge, enabling the force to be measured. 1200 w. Génie Civil—Feb. 18, 1899. No. 26703 D.

Horse-Power.

The Measure of Horse-Power. Considers various arithmetical equivalents of the unit of measure known as a horse-power 2200 w. Engr, Lond—March 10, 1899. No. 26599 A.

Metering.

Metering Compressed Air. F. Schmerber. On the method of determining the amount of compressed air used, meters, tables of multipliers to be used for transforming volumes of compressed air at various pressures into corresponding volumes of free air at atmospheric pressure, etc. 1500 w. Compressed Air—March, 1899. No. 26460.

Power Gas.

The Riché Gas Producer. (Le Gazogène Riché.) An illustrated description of the Riché apparatus, by which an excellent fuel and power gas is produced in connection with the distillation of wood. 2000 w. Génie Civil—Feb. 11, 1899. No. 26701 D.

Lean Gas and the Riché Process. (Gaz Pauvre et Gaz Riché.) A comparison between the cost and value of producer gas and the gas produced by the distillation of wood by the Riché process. 1800 w. L'Electricien—March 18, 1899. No. 26778 B.

Power Plant.

Mechanical Plant of the Boston Southern Terminal Station. Illustrated description of a large plant for electric and refrigerating purposes, containing many novel features. 4200 w. Eng Rec—March 18, 1899. No. 26574.

Rope Driving.

Ropes for Power Transmission. Discusses the different materials used, the three and four strand ropes, and a new form of square rope. 2000 w. Mach, N. Y.—March, 1899. No. 26286.

Tool Driving.

The Horse-Power of Machine Tools. C. H. Benjamin. A summary of the results of many tests to determine the power required to drive machine tools and shafting. 1500 w. Mach, N. Y.—March, 1899. No. 26285.

SPECIAL MOTORS.

Gas Engines.

Gas-Engines as Motive Power in Engineering Works. A. R. Bellamy. Abstract of paper read at meeting of the Manchester Assn. of Engs. A discussion of the cost and some information concerning the methods adopted. Discussion. 3300 w. Jour Gas Lgt—March 14, 1899. No. 26692 A.

Some recent Developments in the Gas Engine Field. Edwin Ruud. Abstract of a paper read before the Technische Ve-

rein, Pittsburg. A talk on the advantages and disadvantages of the two classes most largely used, the gas consumption, water consumption, and the future outlook. Ill. 2300 w. Elec Eng, N. Y.—March 2, 1899. No. 26317.

Petroleum Engine.

The Capitaine Petroleum Engine. From *Zeitschrift des Vereins Deutscher Ingenieure.* Illustrates and describes an oil engine especially designed with the view of meeting the requirements for isolated small powers. 2800 w. Ir Age—March 9, 1899. No. 26423.

The Improved Daimler Motor Vehicles. (Ueber Neure Motorwagen der Daimler Motoren-Gesellschaft.) K. Hallbauer. With numerous illustrations of the application of this compact and convenient petroleum motor to launches, carriages, and heavy vehicles. 1800 w. Glaser's Annalen —March 1, 1899. No. 26735 D.

STEAM ENGINEERING.

Boiler Coverings.

Tests of Locomotive Boiler Coverings. George R. Wallace. A letter commenting on Mr. Quayle's paper which reported tests of locomotive laggings, and indicating the value of the commercial coverings. 1400 w. R R Gaz—March 10, 1899. No. 26451.

Boiler Settings.

The Importance of Proper Boiler Settings in Water-Gas Plants. Jno. R. Lynn. Read at meeting of the Michigan Gas Assn. Notes defects and discusses rules, and fuel tests. 2200 w. Pro Age—March 1, 1899. No. 26321.

Compression.

Compression in Steam Engines (La Compression dans les Machines à Vapeur.) Bryan Donkin. A discussion of the experiments of Prof. Dwelshauvers-Dery in comparison with those made in other countries. 2000 w. Revue de Mécanique —Feb., 1899. No. 26788 H.

Condensers.

Condensing Arrangements at Collieries. Hugh Bramwell. Read before the South Wales Inst. of Engs. Classifies the conditions usually existing, discussing each and the particulars of the work. 2800 w. Col Guard—March 17, 1899. No. 26809 A.

Cylinder Ratios.

Cylinder Ratios for Compound Engines. George I. Rockwood. Condensed from a paper read before the Providence Assn. of Mech. Engs. The views of the writer on the design of compound engines, giving them far larger cylinder ratios, with lengthy editorial discussion. 3800 w. Eng News—March 2, 1899. No. 26344.

Exhaust Steam.

"Regenerating" Exhaust Steam. A criticism of an apparatus recently patented by Hugh J. Barron, which it claims is "a worthless patent for a worse than worthless device." 2300 w. Eng News—March 2, 1899. No. 26343.

Utilization of Exhaust Steam. J. H. Harding. Paper read at convention of the Northwestern Elec. Assn., with discussion. Reports satisfactory heating by the Yaryan system, at La Porte, Ind. 6000 w. Elec, N Y—March 8, 1899. No. 26430.

Explosion.

A Remarkable Boiler Explosion. Illustrates and describes the explosion of the shell of a Scotch boiler on the steamer Francis Joseph I., at Prague, Austria, on the morning of May 19, 1898. 1100 w. Engr, Lond—Feb. 17, 1899. No. 26215 A.

Steam Boiler Explosion at Splitter near Tilsit. (Dampfkesselexplosion in Splitter bei Tilsit.) The official report of a disastrous explosion, with photographs showing the nature and extent of the damage. 2000 w. Zeit d ver Deutscher Ing—March 11, 1899. No. 26729 D.

Feed Water.

Purification of Water for Use in Steam Boilers. James Otis Handy. Considers the troubles due to corrosion, scale formation and foaming; the analysis of the water, and the methods; changes occurring in water in boilers; changes ocused as purifiers; various processes, etc. 10500 w. Pro of Engs' Soc of W Penna —Jan., 1899. No. 26462 D.

Flow.

On the Flow of Steam Through Pipes. A discussion of this problem, with tables. 3000 w. Locomotive—Feb., 1899. No. 26524.

Four-Crank Engines.

Examples of Four-Crank Engines, and Their Auxiliaries. John Thom. Read before the Inst. of Engs. & Shipbuilders in Scotland. Illustrates and describes the principal features. 1800 w. Engs' Gaz—March, 1899. No. 26428 A.

Fuel.

Liquid Fuel. Sir Marcus Samuel. Briefly considers the nature of petroleum, and the conditions in the production and transportation; the advantages in using it as compared with coal. Discussion. 7000 w. Jour Soc of Arts—March 17, 1899. No. 26690 A.

Inventions.

Needed Inventions. Robert Grimshaw. The present article gives general remarks on the subject, and represents the need of a good accumulator or storage battery. 1700 w. Mod Mach—Feb., 1899. Serial. 1st part. No. 25888.

Lubrication.

Concerning Cylinder Oil. W. H. Wakeman. Some points on the quality and quantity of oil to secure the best re-

sults. 1200 w. Am Mach—March 9, 1899. No. 26422.

Marine Engines.

See Marine Engineering.

Mechanical Draft.

The Efficiency of Fuel with Mechanical Draft. Walter B. Snow. Points out the economy secured and possible quantitative advantages. 1500 w. Power—March, 1899. No. 26298.

Pumping Engines.

See Municipal Engineering, Water Supply.

Pumps.

Steam Pumps. J. C. Smith. A discussion of direct-acting pumps, in which the pressure on the steam piston is transmitted through the piston-rod to the water-piston direct, without the intervention of a crank, fly-wheel, or any rotating piece. 4500 w. Engr, U. S. A.—March 1, 1899. No. 26409.

Tests Upon Steam Pumps and Injectors. A collection of valuable data upon pumps of different styles and sizes. H. E. Walton and William Wallace Christie. 1200 w. Mach, N. Y.—March, 1899. No. 26283.

Smoke Prevention.

Internal Combustion Motors and the Prevention of Smoke in Cities. (Verbrennungskraft Maschinen und die Rauchbelästigung der Städte.) Joh Körting. Setting forth the important aid the general introduction of gas and petroleum motors would give to the abatement of the smoke nuisance. 4000 w. Zeit d Ver Deutscher Ing—Feb. 25, 1899. No. 26723 D.

The Smoke Nuisance in Its Legal Aspect. Gives a summary of the existing law in England, reviewing certain Acts of Parliament and some of the more important cases which have been decided. 4300 w. Engng—March 10 1899. No. 26596 A.

Steam.

Steam. W. E. McKay. Read before the New England Assn. of Gas Engs. On the cheap generation of steam. Discussion. 2000 w. Am Gas Lgt Jour—March 13 1899. No. 26503.

Steam Consumption.

The Calculation of Steam Consumption from the Indicator Card. Explains the manner of making the calculations. 1000 w. Prac Engr—March 3, 1899. No. 26511 A.

Steam Mains.

Steam Mains for Electric Supply Stations. R. Summerfield. Discusses the general arrangement, material, joints, expansion, pipe covering, etc. Ill. 1800 w. Engng—March 10, 1899. No. 26595 A.

Supporting Boilers.

On Hooks for Supporting Boilers. Discusses the hooks and their form, giving tabulated statements of safe dead loads for wrought-iron hooks of two forms. 2000 w. Locomotive—Jan., 1899. No. 26145.

Thermal Efficiency.

Comparative Thermal Efficiency of Steam Engines and Diesel Motors. E. D. Meier. The comparison given shows that the Diesel motor has in actual practice far outstripped the theoretical possibilities of the steam engine. Ill. 1800 w. Sib Jour of Engng—March, 1899. No. 26619 C.

Thermodynamics.

A study of the Steam Engine. (Die Beurteilung der Dampfmaschine.) E. Meyer. A discussion of the thermodynamic cycles of the steam engine considered in respect to the possible efficiency to be attained in practice. 2500 w. Zeit d Ver Deutscher Ing—Feb. 11, 1899. No. 26721 D.

Turbines.

Steam Turbines. Rankin Kennedy. Part first considers the turbine from its historical point of view, especially during the past fifty years, and also its construction. 1600 w. Elec Rev, Lond—Feb. 17, 1899. Serial. 1st part. No. 26230 A.

Valve Motions.

The Study of Valve Motions from Diagrams. J. C. Smith. Illustrates and describes the diagram of Prof. Zeuner reduced to a solution easily understood. 2200 w. Engr, U. S. A.—March 15, 1899. No. 26624.

Water-Tubes.

Water-Tube Boilers. Abstracts of two papers read before the Inst. of Civ. Engs., England, with editorial facts concerning the construction of the various types, and interesting points relating to the working, durability, economy, etc. 3300 w. Engr, Lond—March 17, 1899. No. 26808 A.

MISCELLANY.

Address.

A Few Phases in the Rise and Development of the Science of Mechanics. L. Y. Schermerhorn. A summary of the advances of mechanics. 7200 w. Prof. of Engs' Club of Phila—March, 1899. No. 26621 D.

Balloons.

The Balloon as an Instrument of Scientific Research. John M. Bacon. Showing the possibilities of the balloon for investigation. Discussion. 5400 w. Jour Soc of Arts—Feb. 17, 1899. No. 26261 A.

Competition.

America and Germany as Export Competitors and Customers. Louis S. Magee.

Mr. Magee's third paper describes German commercial and industrial methods, and shows the valuable suggestions and conclusions which may be drawn from them. 3000 w. Engineering Magazine—April, 1899. No. 26823 B.

Drawing Instruments.

The Choice and Care of Drawing Instruments. V. T. Wilson. Aims to aid beginners in the choice of tools, and the care needed in handing. 2800 w. Sib Jour of Engng—March, 1899. No. 26621 C.

Enameling.

Enameling as an Industry. Josef Vollkommer. The subject of enameling metals is considered. 2400 w. Ir Age—March 23, 1899. No. 26667.

Engineering Meetings.

Junior Meetings of Engineering Societies. A statement of their importance to young engineers. 900 w. Eng Rec—March 18, 1899. No. 26571.

Explosions.

Explosions Caused by Commonly Occurring Substances. Charles E. Munroe. Address before the Am. Chem. Soc. An interesting study of this class of explosions—as from dust, liquids, vapors, gases, etc., giving many examples. 15800 w. Science—March 10, 1899. No. 26461.

Fans.

See Architectural Engineering, Ventilation.

Friction.

The Molecular Theory of Friction between Polished Solids. (Théorie Moleculaire du Frottement des Solides Polis.) Marcel Brillouin. A brief paper before the French Academy, treating of friction in conection with the molecular theory of work and heat. 1000 w. Comptes Rendus—Feb. 6, 1899. No. 26743 D.

Iron Protection.

See Civil Engineering, Miscellany.

Labor-Saving Machinery.

Attitude of Workmen Toward Labor-Saving Machinery. On the unjust and cruel treatment of inventors of such machines in early times, and the opposition that still exists, although it is clearly shown that they are a benefit to the workmen. 1500 w. Bos Jour of Com—March 11, 1899. No. 26502.

Mechanics.

Familiar Subjects in Mechanics. Samuel Webber. Part first deals with step or cone pulleys. 1400 w. Mach, N. Y.—March, 1899. Serial 1st part. No. 26287.

MILITARY ENGINEERING

Armor.

Krupp Armor Plate. W. L. C. Two interesting communications to the U. S. Naval Committee from Captain O'Neil concerning development of the manufacture of armor plate, and advance in the Krupp-process. 3800 w. Ir Age—March 2, 1899. No. 26296.

Artillery.

The New Field Artillery. Discusses the transformations taking place. 3800 w. Jour U S Artillery—Nov.-Dec., 1898. No. 26,-259 D.

Balloon.

The Visibility of Submarine Boats from Balloons. (Le Ballon Voit le Sons-Marin.) Leo Dex. Showing the availability of the captive balloon for the purpose of detecting the approach of a submarine boat, owing to the wider angle of vision. 2500 w. Revue Technique—March 10, 1899. No. 26720 D.

Battleship.

H. M. Battleship "Glory." Brief illustrated description. 700 w. Engng—March 17, 1899. No. 26804 A.

British Navy.

The Navy Estimates. Editorial discussion of the British Navy estimates, and the circumstances which give them more than the usual interest. 3800 w. Engng—March 17, 1899. No. 26803 A.

Camps.

Hygenic Camps. H. R. Hopkins. Abstract of paper read at the meeting of the Medical Soc. of the State of New York. Discusses the approved appliances of civil life which may be adapted to camp life aiming to prevent disease, by giving clear soil, pure water and fresh air. 1500 w. San—March, 1899. No. 26354 D.

Cruiser.

The Japanese Armored Cruiser "Asama." Brief illustrated description of this twin-screw cruiser recently built. 500 w. Engng—March 3, 1899. No. 26521 A.

The New Cruiser for Japan. Illustrates and describes the "Chitose," the second of the cruisers built in the United States for the imperial navy of Japan. 600 w. Sci Am Sup—March 18, 1899. No. 26548.

Explosives.

Methods for the Examination of Explosives. W. J. Williams. An outline of the methods used for the examination of smokeless powders, as laid down by the regulations of the War Department and

practiced at Frankford Arsenal. Ill. 4500 w. Jour Fr Inst—March, 1899. No. 26-350 D.

Government Vessels.

Special Government Vessels. The Army Transport "Grant" and sister ships. William A. Fairburn. An account of the refitting of the vessels purchased of the Atlantic Transport Line. Ill. 4500 w. Marine Engng—March, 1899. No. 26334 C.

Gun Carriage.

Quick-Firing Field Gun Carriage. Illustrates and describes a field carriage, the characteristic feature consisting in the method of taking up the recoil. 900 w. Engr, Lond—March 10, 1899. No. 26,-604 A.

Italian Navy.

Electricity in the Italian Navy. Giulio Martinez. The first of a series of articles aiming to give a description of the most recent applications of electricity; the description beginning with the generators. Ill. 1400 w. Elec Wld & Elec Eng—March 18, 1899. Serial. 1st part. No. 26584.

Light Artillery.

English Light Artillery. E. Rollin, in Revue d' Artillerie. A summary review of the evolution of the matériel. 1300 w. Jour U S Artillery—Nov.-Dec., 1898. No. 26258 D.

Machinery.

Machinery in Naval Warfare. (Le Macchine nella Guerra Navale.) A. Genardini. A very elaborate discussion of the fundamental importance of efficient and powerful machinery in modern naval warfare. Favourable mention is made of water-tube boilers and the steam turbine. 6000 w. Rivista Marittima—Feb., 1899. No. 26792 H.

Navy.

The Necessary Navy. (L'Armata Necessaria.) G. Astuto. A discussion of the conditions which indicate the degree of naval strength which should be possessed by a nation; with especial consideration of the position of Italy. 3500 w. Rivista Marittima—Jan., 1899. No. 26791 H.

Range Finder.

A Horizontal-Base Range and Position Finder for Coast Artillery. George O. Squier and Albert C. Crehore. Description and brief account of the development of the instrument. Ill. 3200 w. Jour U. S. Artillery—Nov.-Dec., 1898. No. 26257 D.

Santiago.

The Performance of Individual Ships at Santiago. Outlining the action of individual ships to determine how they fulfilled their parts. Ill. 2800 w. Engr, Lond—Feb. 24, 1899. No. 26372 A.

Smokeless Coal.

Coal for Naval Vessels. Reports a discussion following the introduction of an amendment to the Naval Bill appropriating $20,000 to test the qualities of smokeless coal; gives reasons for the preference for bituminous coal. 2000 w. Marine March 9, 1899. No. 26470.

Submarine.

A Visit to the Goubet No. 2. (Une Visite au Goubet No. 2.) E. Duboc. An interesting description of this small submarine boat at Saint-Ouen, and a comparison with the Gustave Zédé. 2500 w. Le Yacht —Feb. 18, 1899. No. 26716 D.

Torpedo Boats.

On the Shape of Torpedo Boats. H. C. Vogt. Illustrates and describes a model, stating its desirable points. 1000 w. Steamship—March, 1899. No. 26509 A.

Torpedo Boat Practice. William W. Kimball. Suggestions as to the construction, repair and equipment. 2800 w. Marine Rev—March 2, 1899. No. 26322.

Turrets.

The Improved Turrets of the Battleship "Texas." Robert W. Henderson. Illustrates and describes the improvements instigated by Lieut. F. J. Haeseler, showing the method of loading the guns. 2200 w. Sci Am—April 1, 1899. No. 26827.

War Lessons.

The Lessons of the Spanish-American War. Editorial discussion of Admiral Colomb's paper. 3000 w. Engng—March 10, 1899. No. 26597 A.

Warships.

The Monitor, the Battle-ship, the Cruiser, and the Destroyer. G. W. Dickie. A critical discussion by the general manager of the Union Iron Works, of San Francisco, of the design and equipment of the several classes of war ships, from the viewpoint of the engineer and shipbuilder. 3500 w. Engineering Magazine—April, 1899. No. 26815 B.

Wire Guns.

New Type Wire Guns. Part first gives illustrated description of the service wire guns as given by the Royal Gun Factory. 1500 w. Engr, Lond—Feb. 24, 1899. Serial. 1st part. No. 26374 A.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

Anthracite Coal in Peru. William Griffith. Reports concerning the topography and climate, geology, coal fields, etc. Maps and sections. 6000 w. Jour Fr Inst —March, 1899. No. 26352 D.

Coal Dust.

The Utilization of Coal Sludge and Coal Dust. From *Neues Saarbrueckener Gewerbeblatt.* Gives the principal features of the Bechem and Post system of water-spray firing and the results of trials. 900 w. Col Guard—March 17, 1899. No. 26810 A.

Coal Getting.

Across the Pitch versus Up the Pitch. O. E. S. Whiteside. Read before the Canadian Mining Inst. A comparison of the two methods. 1200 w. Can Min Rev—Feb. 28, 1899. No. 26304 B.

Coal Measures.

Fossil Plants of the Coal Measures as Stratigraphical Guides. Mark Stirrup. Abstract of paper read before the Manchester (Eng.) Geol. Soc. On the use that might be made of these plants as time marks. 1300 w. Col Guard—March 17, 1899. No. 26812 A.

Commentry.

Early Working in the Commentry Coal-field. M. Martinet. From a communication to the Société de l'Industrie Minérale. Describes the deposits and various phases of working. 3500 w. Col Guard—Feb. 24, 1899. No. 26364 A.

Cost Sheet.

A Colliery Cost Sheet. G. Johnson. Illustrations of bank and underground pay-bills are given, with remarks on the importance of the cost sheet. 1100 w. Col Guard—March 3, 1899. No. 26535 A.

Explosives.

Safety Explosives. Oscar Guttmann. From a paper read before the Soc. of Chem. Ind. Deals with the present state of knowledge and gives suggestions with regard to explosives for the purpose of blasting in coal mines where the presence of inflammable gas and coal dust constitute a danger. 4200 w. Col Guard—March 10, 1899. No. 26591 A.

Lignite.

Brown Coal Mining in the Rhineland. From a report by Dr. Niessen, British Vice-Consul at Cologne, describing the deposits and working of the mines. 900 w. Col Guard—March 10, 1899. No. 26592 A.

Natal.

Coal in Natal. Extracts from the report of a commission appointed to investigate the coal industry of Natal. 1200 w. U. S. Cons Repts. No. 379—March 21, 1899. No. 26607 D.

Oven.

A Description of the Semet-Solvay By-Product Coke-Oven Plant at Ensiey, Alabama. William Hutton Blauvelt. Illustrates and describes a new plant recently put in operation, and compares the by-product oven and its operation, with the beehive oven. 3500 w. Trans Am Inst of Min Engs—Oct., 1898. No. 26243 D.

The Coking, in Beehive Ovens, of the Coals of the New River District, West Virginia. Charles Catlett. Gives observations made of the burning of a set of eight ovens by means of the draft-boxes, the observations extending over a period of about two weeks. 3000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26239 D.

Russia.

The Coal and Iron Resources of Russia. Part first gives particulars, hitherto unpublished, relating to the coal and mineral deposits of the Caucasus. 2200 w. Ir and Coal Trd Rev—Feb. 17, 1899. Serial. 1st part. No. 26210 A.

Siberian Coal.

The Vladivostok Coal Field in Siberia. Russell L. Dunn. Describes this field and the kinds and quality of coal found. Also the favorable transportation facilities. Ill. 1300 w. Eng and Min Jour—March 11. 1899. No. 26469.

Statistics.

The Coal and Iron Ore Mining Industries of the World. C. Le Neve Foster. From the general report for 1897 on mines and quarries. Statistics of all kinds of solid mineral fuel, and the working of the mines. 4000 w. Col Guard—March 10. 1899. No. 26590 A.

Washing Plant.

New Washing Plant at the Blanzy Colliery. M. Graillot. From a communication to the Burgundy section of the Société de l'Industrie Minérale. Gives particulars and illustrations of a new plant capable of washing 800 tons of coal in ten hours. 2600 w. Col Guard—March 3. 1899. No. 26534 A.

COPPER.

Deposits.

The Copper Deposits of Person County, North Carolina, and Halifax County, Virginia. William B. Phillips. An account of what promises to be a good copper district. 900 w. Am Mfr and Ir Wld—March 17, 1899. No. 26569.

Mattes.

The Elimination of Impurities from Copper-Mattes in the Reverberatory and the converter. Edward Keller. Continued discussion of this paper. 3500 w. Trans Am Inst of Min Engs—Feb., 1898. No. 26252 D.

Prices.

The Position of Copper and Tin. Editorial on the rise in prices of these metals owing to growing consumption and limit of visible supplies. 1600 w. Engr, Lond—March 3, 1899. 26526 A.

South Africa.

The Moonta. A brief account of the discovery, deposits and value of this copper mine. 1000 w. Aust Min Stand—Feb. 9, 1899. No. 26505 B.

Supply.

Copper. The prices, production, supplies and consumption are discussed. 1600 w. Eng and Min Jour—March 11, 1899. No. 26466.

GOLD AND SILVER.

Alluvial Mining.

Some Notes on Alluvial Mining in New Zealand. Jno. W. Gray. Notes taken mainly from information given in the Government report, showing unabated interest in alluvial mining. 1600 w. Min & Sci Pr—Feb. 25, 1899. No. 26341.

Beach Sands.

Gold-Bearing Beach Sands of California. Arthur Lakes. How they are formed, deposited, and concentrated by the waves of the ocean. 900 w. Mines & Min—March, 1899. No. 26392 C.

Colorado.

Prospecting Districts of Northern Colorado. Marshall D. Draper. Gives description and formation of some promising localities. Map. 3500 w. Min Rept—March 16, 1899. No. 26632.

Cyanide.

Wet-Crushing with Cyanide. Arthur H. Thorpe. A general description of the method followed with much success in one of the leading mills in New Zealand. 900 w. Aust Min Stand—Jan. 19, 1899. No. 26310 B.

Density-Rule.

A Prospectors' Density Rule. J. Holms Pollock. Illustrates and describes the device and its use. 900 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26240 D.

Denver Mint.

The Denver Mint. Thomas Tonge. The first coinage of gold there by a private firm in the early "sixties." Great increase in Colorado's annual gold production. The careful methods followed. Ill. 2800 w. Mines & Min—March, 1899. No. 26388 C.

Desilvering.

The Electrolytic Desilvering of Argentiferous Lead. (Désargentation Electrolytique des Plombs Argentifères.) A description of the Tommasi process. A solution of double acetate of lead and sodium is used, pure crystals of spongy lead being deposited on the cathode, the silver falling to the bottom of the tank. 1800 w. L'Electricien—March 4, 1899. No. 26775 B.

Dredging.

Dredging for Gold. Robert Norman Bell. The construction of dredges which successfully work gravel which cannot be profitably handled by other means. 1600 w. Mines & Min—March, 1899. No. 26395 C.

Extraction.

Methods of Gold Extraction by Electrolysis. C. A. Mulholland. Part first notes the causes of wasted energy on useless contrivances and reviews the attempts made to introduce electrolysis into the process of amalgamation. 2500 w. Aust Min Stand—Jan. 12, 1899. Serial. 1st part. No. 26309 B.

Fuel.

Fuel at the Caylloma Mines, Peru. Information concerning the difficulty in obtaining fuel at this silver mine, and the various expedients. Ill. 1100 w. Ir & Coal Trds Rev—Feb. 24, 1899. No. 26378 A.

Gold Veins.

The Gold-Bearing veins of Bag Bay Near Lake of the Woods. Peter Mackellar. Describes the geological formation mining developments, vein characteristics and peculiarities. 4200 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26248 D

Klondike.

A Journey to the Klondike (Eine Reise nach Klondyke.) Zdenko Horovsky. An excellent account of the methods of mining for gold in the Klondike region, being an address by a Bohemian engineer, relating his experiences. 3500 w. Zeit d Oesterr Ing u Arch Ver—March 3, 1899. No. 26733 B.

Losses.

Losses of Gold in Mill Water. A. von Gernet. Gives results of experiments and calls attention to sources of danger of cyanide contamination. 1100 w. Jour of Chem & Met Soc of S Africa—Jan., 1899. No. 26440 E.

Mexico.

The Gold Resources of Mexico. V. R de Cornely. Part first describes the auriferous veins and the progress of the gold mining industry. 2000 w. Eng & Min Jour. March 18, 1899. Serial. 1st part No. 26585.

New Gold Districts.

The Discovery of New Gold Districts H. M. Chance. Calls attention to valuable accidental discoveries, and to investigations which have led prospectors to decide that the only safe way is to assay everything. 2500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26244 D

Nova Scotia.

Nova Scotia Gold Mines. George W Stuart. On the changes in the system of mining and milling which have placed the business on a permanent basis. 1000 w. Eng & Min Jour—March 11, 1899. No. 26468.

Oregon.

Eastern Oregon Gold Belt. John F. Leland. Brief mention of a few of the active mines of this section showing a bright outlook. 900 w. Min Rept—March 9, 1899. No. 26506.

Placer Deposit.

A North Carolina Hydraulic Proposition. Illustrated description of the plant of the Irvindale Mining Co. 700 w. Eng & Min Jour—March 11, 1899. No. 26467.

Precipitation.

A Zinc Process for Precipitating Gold from Weak Solutions. T. L. Carter. Continued discussion of this paper. 5000 w. Jour of Chem & Met Soc of S Africa—Jan., 1899. No. 26441 E.

Production.

Marvelous Increase in Production of Gold. Alexander E. Outerbridge, Jr. A study of the gold production of the world, the increase due to progress in mining and metallurgical arts, and facts of interest concerning this precious metal. 3200 w. Ap Pop Sci M—March, 1899. No. 26282 D.

Solutions.

The Theory of Solutions. A. von Oettingen. An outline of newly-discovered laws, and their application. 4000 w. Jour of Chem & Met Soc of S Africa—Jan., 1899. No. 26442 E.

Stamp Mills.

An Improved Method of Introducing Feed Water to the Stamp-Mill Mortar. Bernard MacDonald. Read before the Canadian Mining Inst. Claims an increase of crushing capacity, decrease of sliming, and perforation of the bottom of the mortar to retain and protect the coarse gold from abrasion. 1200 w. Can Min Rev—Feb. 28, 1899. No. 26303 B.

Notes on Steam and Other Stamps. C. H. Fitch. Summary of information from various sources showing the progress. 1800 w. Min & Sci Pr—March 4, 1899. No. 26498.

Utah Mines.

Bingham Canyon Mines. Don Maguire. A description of one of the oldest and still one of the richest mining camps of Utah. A history of the early discoveries of silver-lead ore and their development into great producers of lead, silver, gold and copper. 3000 w. Mines & Min—March, 1899. No. 26394 C.

West Africa.

The Gold Mines of West Africa. James Irvine. Brief sketch of the hsitory of this coast showing the richness in gold, and giving information concerning the climate, and conditions of the country. Also discussion. 7000 w. Jour Soc of Arts—Feb. 24, 1899. No. 26385 A.

IRON AND STEEL.

Cast Iron.

See Mechanical Engineering, Machine Works and Foundries.

Chemistry.

The Relation of Chemical Composition and Microscopic Structure to the Physical Properties of Iron and Steel. (Zuzammenhang der Chemischen Zuzammensetzung und des Mikroskopschen Gefüges mit den physikalischen Eigenshaften von Eisen und Stahl.) Hanns Freiherr von Jüptner. An important paper by the leading authority in Germany, giving the latest information on these much discussed points. Two papers, 5000 w. Stahl und Eisen—March 1, 15, 1899. No. 26741 each D.

Chilled Rolls.

Chilled Rolls, and Why They Break. E. D. Nicholson. The analysis of iron for making rolls is considered and the causes of breakage discussed. 4400 w. Ir & Coal Trd Rev—Feb. 17, 1899. No. 26211 A.

Costs.

A Decade of Progress in Reducing Costs. C. Kirchhoff. Presidential address before the Am. Inst. of Min. Engs. Notes discoveries and improvements in practice and equipment which have contributed to progress in reducing costs, showing the effect on pig iron, Bessemer ingots, rolling rods, and lead smelting. 3700 w. Ir. Age—March 2, 1899. No. 26295.

Hardening.

Early Methods of Hardening Steel. (Stahlhärten in Früheren Zeiten.) Otto Vogel. A contribution to the history of iron, showing the development of the present knowledge from the earliest times. 3000 w. Stahl und Eisen—March 1, 1899. No. 26742 D.

Iron Ore.

The Cumberland Iron-Ore Deposits. W. Wilson Barnes. Considers the probability of new discoveries of hematite iron-ore, and things necessary to secure prosperity for the British iron and steel industry. 2000 w. Ir & St Trds Jour—Feb. 18, 1899. No. 26279 A.

Iron Tract.

The Rich Patch Iron Tract, Virginia. H. M. Chance. Describes the location, topography, geology, ores, mining development, and methods. Ill. 3500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26241 D.

Kytchtym Medal.

The Kytchtym Medal. Dr. Persifor Frazer. Discussion of paper presented at the meeting of Dec., 1897. Ill. 1200 w. Trans Am Inst of Min Engs—Oct., 1898. No. 26254 D.

Limonites.

The Limonites and Their Use in the Blast Furnace. J. C. Foster. Considers these ores and the manner of treating them, the plan of buying the ores on the basis of analysis, the objections to them, etc. 1200 w. Am Mfr & Ir Wld—March 17, 1899. No. 26568.

Manganese.

Manganese in the Acid Open-Hearth Process. F. A. Matthewman. Abstract of a paper read before the West of Scotland Ir and Steel Inst. Presents the principal effects of manganese in this process, the statements being founded on practical observations. 2700 w. Ir & Coal Trds Rev—March 17, 1899. No. 26806 A.

Production.

British Production of Steel in 1898. Statistics showing a decrease on the previous year. 800 w. Col Guard—March 17, 1899. No. 26811 A.

Rolling Mill.

A Modern Sheet Bar Mill. Describes the bar mill of the National Steel Co.'s Shenango Valley plant, at New Castle, Pa. 1500 w. Ir Trd Rev—March 9, 1899. No. 26438.

Rolls.

The Design of Roughing Rolls. William Hirst. Considers improvements and economy in roll turning, discussing the gothic, the diamond, and the box pass, and the classes of work for which they are adapted. 6200 w. Ir Age—March 16, 1899. No. 26537.

Swedish Iron.

Swedish Iron Metallurgy and Its Application to Canada. James Douglas. Read before the Canadian Mining Inst. Compares the similar conditions of Canada and Sweden, and shows how the former country may learn from the latter. 4800 w. Can Min Rev—Feb. 28, 1899. No. 26306 B.

Tuyeres.

Tuyeres in the Iron Blast Furnace. Contributions to the discussion of this subject by B. F. Fackenthal, Jr., John M. Hartman, R. W. Raymond and others. Ill. 11000 w. Trans Am Inst of Min Engs—Oct., 1898. No. 26245 D.

Valves.

Hot-Blast Valves. James Robinson. Read before the West of Scotland Iron and Steel Inst. A record of the hot-blast valves the writer has had in use, their working, design, defects, alterations, and improvements. Ill. 1800 w. Ir & Coal Trd Rev—Feb. 17, 1899. No. 26208 A.

MINING.

Ancient Rivers.

Mysteries of the Ancient Rivers of the Forest Hill Divide, Placer Co., Cal. An account of the discovery of what is presumed to be a continuation of the rich channel worked in former years in the Dix mine, with information concerning these channels. Ill. 1500 w. Min & Sci Pr—March 18, 1899. No. 26646.

Explosives.

Safety Explosives for Gaseous Mines. (Ueber Sicherheitssprengstoffe für Schlagwettergruben.) A critical comparison of the various safety explosives used in Germany, in connection with the possible ignition of fire damp. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 4, 1899. No. 26754 B.

The Testing of Explosives for Mining Purposes. A report by Major A. Cooper-Key to the chief inspector of explosives on the working of the Home Office Testing Station for the year 1898. 4500 w. Col Guard—Feb. 24, 1899. No. 26360 A.

Fan.

The Patton Fan. Ernest Brackett. The methods used in calculating its proportions and some particulars of tests of its efficiency. Ill. 2800 w. Mines & Min—March, 1899. No. 26393 C.

Fire Damp.

Report of the Committee for the Investigation of the Firedamp Question. (Mitteilungen der Ständigen Comités zur Untersuchung von Schlagwetterfragen.) Giving the results of the work of the Austrian commission, with especial reference to safety primers, explosives, and lamps. 3000 w. Glückauf—Feb. 11, 1899. No. 26750 B.

Hoisting.

A Remarkable Hoisting Engine. Geo. S. Binckley. Describes an engine at the Bell mine, one of the properties of the Anaconda Copper Co., and its operation. 2500 w. Min & Sci Pr—Feb. 25, 1899. No. 26340.

Machine Mining.

Machine Mining of Bituminous Coal. William Edwin Hall. A review of the machinery used, and its effect on the capacity of production, and health and safety of the miners. 1800 w. Yale Sci M—Feb., 1899. No. 26256 C.

Mine Signaling.

See Electrical Engineering, Communication.

Mine Surveyors.

The Education of Mine Surveyors in Prussia. Bennett H. Brough. A summary of the regulations for the examination of mine surveyors recently adopted. 900 w. Col Guard—Feb. 17, 1899. No. 26225 A.

Mining Practice.

Notes on Michigan Mining Practice. W. L. Hildburgh. Notes on mine plants and methods of mining in the iron and

copper regions. 11300 w. Sch of Mines Quar—Jan., 1899. No. 26588 D.

Nova Scotia.

On the Proposed Revision of the Mines Act of Nova Scotia. Alex. McNeill. From *Proceedings* of Dec. meeting of the Mining Society of Nova Scotia. An examination of the proposed law, with general discussion. 6000 w. Can Min Rev—Feb. 28, 1899. No. 26301 B.

Shaft-Sinking.

Hoisting Device for the Sinking of the Emscher I shaft. (Fördereinrichtung beim Abteufen des Schachtes Emscher I.) An auxiliary shaft, enclosed within the main shaft contained a special hoisting plant which enabled the sinking to proceed without the interruption of regular work. 800 w. 1 plate. Glückauf—March 11, 1899. No. 26752 B.

Sinking a Shaft at the Victor Colliery. Westphalia. From an article founded on papers by Herr Pieler and Herr Hennenbruch, in *Glückauf*. Illustrates and describes a difficult work. 5700 w. Col Guard—Feb. 17, 1899. No. 26227 A.

Sinking Deep Shafts by the Freezing Process. Abstract of a paper in the *Revue Universelle des Mines*. States the conditions to be observed. Ill. 1200 w. Eng & Min Jour—March 18, 1899. No. 26586.

Ventilation.

Compression Ventilators at the Schlesien and Deutschland Pits (Upper Silesia.) Bergassessor Steinhoff, *Zeitschrift für Berg-Hutten und Salinen-wesen*. Illustrated description, with statement of advantages of this system. 2000 w. Col Guard—March 17, 1899. No. 26813 A.

Root Principles of Mine Ventilation. Points out some of the principles associated with the theory of heat, which should be understood by students of mine ventilation. 6000 w. Col Guard—Feb. 24, 1899. Serial. 1st part. No. 26363 A.

The Ventilation of the Schlesien and Deutschland Collieries by Blowers. Abstracted from article in *Zeitschrift für das Berg-Hutten-und Salinenwesen*. A description of the ventilation of two collieries by means of blowers placed underground. Ill. 1000 w. Ir & Coal Trds Jour—Feb. 24, 1899. Serial. 1st part. No. 26377 A.

MISCELLANY.

Alloys.

Alloys. William C. Roberts-Austen. Read before the British Inst. of Mech. Engs. The fifth report of the alloys research committee. Ill. 3000 w. Engng—Feb. 17, 1899. Serial. 1st part. No. 26220 A.

Note on the Disintegration of an Alloy of Nickel and Aluminum. Erwin S. Sperry. Reports oft-repeated experiments showing an alteration in half-and-half alloy. 500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26238 D.

Aluminum.

The Progress of Aluminum. A review of progress during the past two years in the manufacture and utilization of aluminum and its alloys. 4500 w. Engr, Lond—Feb. 17, 1899. No. 26213 A.

Chromite.

The Occurrence, Origin, and Chemical Composition of Chromite; with Especial Reference to the North Carolina Deposits. J. H. Pratt. A careful study of these deposits was made by the writer and he gives reasons why the chromite should be regarded as having been formed at the same time with the peridotites. 8000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26246 D.

Clay Deposits.

A Geologic and Economic Survey of the Clay-Deposits of the Lower Hudson River Valley. Clemens Catesby Jones. Gives an account of investigations made to determine in a practical manner the location, form and extent of all the clay-deposits at present existing in the lower Hudson River Valley, and to ascertain the quantity and suitability of a clay for the manufacture of common building bricks. Ill. 10500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26247 D.

Cornish Mines.

Cornish Mines and Cornish Miners. J. H. Collins. An interesting account of this district and the minerals found, with special review of the great tin and copper industries, the peculiarities of mining, the production, etc. Also discussion. 14600 w. Jour Soc Arts—March 10, 1899. No. 26614 A.

Corundum.

Corundum in Ontario. Archibald Blue. Gives an account of the first discovery and of later researches which proved the mineral to exist in Canada in commercial quantity. 5300 w. Trans Am Inst of Min Engs—Oct., 1898. No. 26249 D.

The Abrasive Efficiency of Corundum. W. H. Emerson. Discusses, I. The relation between the "effective hardness" of corundum and its content of water: II. Smith's test as a means of determining the abrasive efficiency of corundum. 6500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26242 D.

Diamonds.

The Occurrence and Origin of Diamonds in California. H. W. Turner. Reports concerning the occurrence and number of diamonds found, with discussion of the origin. 3000 w. Am Geol—March 1899. No. 26431 D.

Electric Smelting.

See Electrical Engineering, Electrochemistry.

Electro-Metallurgy.

See Electrical Engineering, Electrochemistry.

Machinery.

Metallurgical Machinery. A. C. McCallum. Read before the Canadian Mining Inst. Deals with the most familiar machines used by miners, such as crushers, rolls, stamps, and feeders, from the designer's point of view. 4000 w. Can Min Rev—Feb. 28, 1899. No. 26305 B.

Mica.

Mica Mining in Bengal, India. A. Mervyn Smith. Read before the Institution of Mining and Metallurgy. Describes the mines and native methods of mining, also the present method of work. 2500 w. Col Guard—Feb. 24, 1899. No. 26362 A.

Natural Gas.

Natural Gas in Colorado. Arthur Lakes. Deals with the origin of natural gas and petroleum, and their relations to bituminous shale and asphaltum, describing the White River gas field. 2500 w. Mines & Min—March, 1899. No. 26389 C.

Platinum.

The Platinum Deposits of the Tura River System, Ural Mountains, Russia. C. W. Purington. Illustrates and describes the principal platinum-producing district of the world, its discovery, the value of the deposit, manner of working, etc. 4500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26250 D.

Porto Rico.

The Mineral Resources of Porto Rico. W. L. C. Abstract of the preliminary report of Robert T. Hill, who has recently returned from a tour of investigation to determine the mineral resources. 1500 w. Ir Age—March 16, 1899. No. 26538.

Quicksilver.

New Almaden Mines of Santa Clara County, California. Arthur Lakes. These mines are the principal producers of quicksilver in the United States. Gives a description of their peculiar features, their geological formation, and a comparison of them with the older mines of Almaden in Spain. 3800 w. Mines & Min—March, 1899. No. 26390 C.

Standards.

Metallurgical Standards. Frederick T. Snyder. Read before the Canadian Mining Inst. Discusses the unit of weight, the scale of sizes for crushed ore, and a coefficient that shall represent the mechanical condition of the ore. 2200 w. Can Min Rev—Feb. 28, 1899. No. 26302 B.

Thermometry.

The Measurement of High Temperatures. T. H. Waller. Abstract of a paper read before the South Staffordshire Inst. of Iron and Steel Works Managers.. Reviews the various methods, favoring the thermo-couple of platinum and rhodium platinum. 1600 w. Ir & Coal Trds Rev—March 17, 1899. No. 26805 A.

Vanadium.

See Electrical Engineering, Electrochemistry.

Zinc.

A New Method for the Determination of Zinc. A. C. Laugmuir. Presented to the Am. Chem. Soc. Describes the phosphated method which is largely used in America. 1200 w. Ind & Ir—March 10, 1899. No. 26594 A.

MUNICIPAL ENGINEERING

GAS SUPPLY.

Acetylene.

Acetylene. A discussion of progress made with this illuminant, the researches made at Pintsch's gas works at Berlin and Fürstenwalde, trouble with the burners, etc. Ill. 3800 w. Engng—March 17, 1899. No. 26802 A.

Report of the Acetylene Exhibition Committee. A review of this report and statements concerning its value to those interested in the conditions of safety in acetylene generators. 1300 w. Engr. Lond—March 3, 1899. No. 26525 A.

The Conditions of Temperature Existing in Acetylene Generators. Results of experiments as given in report of Vivian B. Lewes. 4800 w. Jour Gas Lgt—March 7, 1899. No. 26552 A.

The Municipal Acetylene Plant at Oliva. (Die Acetylen Stadtanlagen in Oliva.) Dr. Paul Wolff. A description of a municipal plant for a small town in Eastern Prussia, with illustrations of the generating house and piping. 1800 w. Ill Zeitschr f Klein u Strassenbahnen—Jan. 16, 1899. No. 26786 D.

Address.

Inaugural Address before the Manchester District Institution of Gas Engineers. R. G. Shadbolt. Review of progress in the gas industry. 6000 w. Jour Gas Lgt—Feb. 28, 1899. No. 26426 A.

Inaugural Address before the Southern District Association of Gas Engineers and Managers. A. E. Broadberry. Discusses carburetted water gas and its use, and various troubles at Tottenham, with brief

references to matters of interest to the gas industry. 6200 w. Jour Gas Lgt—Feb. 14, 1899. No. 26207 A.

Analysis.

Analysis of Blast-Furnace Gas While Blowing In. Ralph H. Sweetser. Describes investigations made at Sparrow Point, Md. 1600 w. Trans Am Inst of Min Engs—Oct., 1899. No. 26251 D.

Modified Apparatus for Gas Analysis. E. Hœnkus. in *Zeitschrift für Berg und Huttenwesen.* Illustrates and describes an apparatus designed by the writer, a modification of the Orsat apparatus, to enable hydrogen and gases of the CnH_{2n} series to be determined in the presence of carbon monoxide and methane in fire-damp and blast-furnace gases. 1400 w. Col Guard—March 3, 1899. No. 26533 A.

Combustion.

Recent Researches upon the Products of Combustion of Illuminating Gas. (Nouvelles Recherches sur les Produits de Combustion du Gaz d'Eclairage.) Dr. Grehant. An account of the latest investigations into the injurious products of burning gas, comparing various burners. 6000 w. Bull de la Société d'Encour—Feb., 1899. No. 26738 G.

Distribution.

Distributing Gas at Pressures Higher Than Usually Obtained with a Holder. B. J. Allen. Read at meeting of New England Assn. of Gas Engs. Describes the method used by the Brookline Gas Light Co. Discussion. 4300 w. Am Gas Lgt Jour—Feb. 27, 1899. No. 26273.

Enrichment.

Enrichment of Coal Gas. George H. Harper. A summary of what has been said and written on this subject. 2500 w. Gas Engs' Mag—Feb. 10, 1899. Serial. 1st part. No. 26234 A.

Gasholders.

Some Notes on the Construction of a Concrete Gasholder Tank. C. W. Andrews. Read at meeting of the Ohio Gas Light Assn. Describes the construction, which cost about two-thirds of what a similar brick tank would have cost. Discussion. 3000 w. Am Gas Lgt Jour—March 27, 1899. No. 26682.

The Action of Gasholder Cups. Considers the principles which govern their action. Part first discusses the approximate working conditions, general behavior of the water levels, action of cups when descending into tank, behavior of the gas entrapped in grip, and behavior of water-levels in grip. 1500 w. Gas Wld—Feb. 18, 1899. Serial. 1st part. No. 20-202 A.

Gas Plant.

Notes on the Design and Extension of Gas Plant. J. J. Humphreys, Jr. Read at meeting of New England Assn. of Gas Engs. Calls attention to facts of importance in planning works. 4200 w. Am Gas Lgt Jour—Feb. 27, 1899. Serial. 1st part. No. 26274.

Lighting Apparatus.

The Auto-Lux from *La Nature.* Illustrated description of an apparatus for lighting and extinguishing gas at a distance. 700 w. Sci Am Sup—March 11, 1899. No. 26436.

Main Laying.

A Few Practical Notes on Main Laying. Lester Price. Considers material for street mains, distribution, pipe laying, lead joints, back filling, etc. 2000 w. Am Gas Light Jour—March 20, 1899. No. 26629.

Mantle.

A New Incandescent Gas Mantle. Information concerning the invention of William Lawrence Voelker, of Elizabeth, New Jersey. 2000 w. Jour Gas Lgt—Feb. 14, 1899. No. 26206 A.

The "Jasper" Incandescent Gas Mantle. Gives information concerning a mantle in demand in Germany, but not widely known elsewhere, with tests of its durability and report of its appearance. 1300 w. Jour Gas Lgt—March 14, 1899. No. 26691 A.

Naphthalene.

The Naphthalene Question. Dr. P. Eitner. Abstract translation of a paper read before the Mid-Rhemish Assn. of Gas and Water Engs., with editorial. A valuable contribution to the solution of this question. 4600 w. Jour Gas Lgt—Feb. 21, 1899. No. 26312 A.

Nuisance.

The Nuisance Question in Gas Works. Frederick H. Shelton. Read at meeting of New England Assn. of Gas. Engs. Discusses what constitutes a nuisance, and precautions that will avoid grounds for complaint. Also discussion. 3800 w. Am Gas Lgt Jour—March 6, 1899. No. 26396.

Water Gas.

A Beginner's Experiments in Studying the Operation of a Lowe Water-Gas Apparatus. J. B. Polk. Read before the New England Assn. of Gas Engs. A report of experiments made by the writer. 3000 w. Am Gas Lgt Jour—March 13, 1899. No. 26504.

Carburetted Water Gas. The Home Office report, with appendices treating of the subject under inquiry, concerning the extent of the manufacture, the danger, and the regulations necessary. 7800 w. Gas Wld—Feb. 18, 1899. No. 26203 A.

Home Office Inquiry into the Supply of Water-Gas. Text of the unanimous report of the Departmental Committee, with editorial comment. 32700 w. Jour Gas Lgt—Feb. 21, 1899. No. 26311 A.

Innovation in and Future of the Water-Gas Industry. Adapted and translated from a paper read by H. Croissant, at a meeting of the Mid-Rhenish Assn. of Gas and Water Engs. Reviews briefly the differences of the two methods of producing gas from coals; describes the Dellwick and Strache generators, and gives interesting information in part first. 2500 w. An Gas Lgt Jour—March 20, 1899. Serial. 1st part. No. 26628.

SEWERAGE.

Filtration.

Notes on the Operation of the Sewage Filter Beds of Plainfield, N.J. An account of the operation of this intermittent filtration system which has been in use three years. Ill. 1000 w. Eng News—March 16, 1899. No. 26553.

Havana.

Sewerage of Havana. Part first gives a statement of the present conditions. 700 w. Fire and Water—Feb. 25, 1899. Serial 1st part. No. 26272.

Rain Precipitation.

Tables of Excessive Precipitations of Rain at Chicago, Ill., from 1889 to 1897 Inclusive. Edwin Duryea, Jr. Facts considered important as data for sewerage engineers in proportioning the sizes of sewers for the removal of rainfall. 4000 w. Tables. Jour of Soc of Engs—Feb., 1899. No. 26833 D.

River Pollution.

I. Report of the New Jersey River-Pollution Commission. II. An Important Decision on River Pollution by Sewage in New Jersey. Gives that portion of the report which refers to the condition of the lower Passaic River, in the first article. The second gives an important decision rendered by the Chancery Court of New Jersey. 3300 w. Eng News. March 9, 1899. No. 26449.

The Pollution of thePassaic River. Review of two decisions restraining the cities of Paterson and Newark from discharging sewage into a large stream. 700 w. Eng Rec—March 18, 1899. No. 26573.

Sanitation.

Perfect Sewerage and Perfect Health. G. M. Sinclair. Read before the Nat. Assn of Master Plumbers. Shows that good sewerage lessens the death rate, discusses sewerage systems and the disposal of sewage. 1800 w. Met Work—March 18, 1899. No. 26587.

Sewage Disposal.

A Hospital Sewage Disposal System. Illustrated description of the combined chemical treatment and filtration system installed at the Southern Hospital for the Insane, Evansville, Ind. 700 w. Eng Rec—March 11, 1899. No. 26477.

Bacillite Sewage Disposal at Hanley, England. Describes a unique system of chemical treatment. 800 w. Eng Rec—March 25, 1899. No. 26678.

Chemical Sewage Treatment, Brooklyn, N. Y. Illustrated description of works for treating about 5,000,000 gals. of sewage daily by the Powers patented process. 800 w. Eng Rec—March 25, 1899. No. 26674.

Some Methods of Sewage Disposals. W. M. Watson. Describes the methods employed in the sewage purification systems of the late George E. Waring and Jerome Deery. 2500 w. Can Engr—March, 1899. No. 26546.

The Exeter Septic Tank System. Reviews the explanation given by the designer, Donald Cameron, of the principles of the system and a statement of the results attained with the first permanent plant. 3500 w. Eng Rec—March 25, 1899. No. 26675.

Sewerage Project.

The New Massachusetts Metropolitan Sewerage Project. Explains the main features of a $4,600,000 undertaking for the district south and west of Boston. 500 w. Eng Rec—March 18,1899. No. 26572.

Sewers.

A New Form of Sewer Invert Block. Arthur N. Talbot. Read before the Illinois Soc. of Engs. and Survs. A comparison of circular and egg-shaped sewers, with description of a new form of invert block for use with circular sewers. 900 w. Munic Engng—March, 1899. No. 26,329 C.

New Units in the Design of Sewers. A discussion of the methods used in determining the unusually large amount of sewage per capita, 300 gals., on which the design of the south metropolitan sewers of Massachusetts were based. 1100 w. Eng Rec—March 25, 1899. No. 26668.

Studies for a High-Level Gravity Sewer for Boston and Vicinity. From a report of the Metropolitan Sewerage Commission recommending a plan for a high-level gravity sewer for the Charles and Neponset River valleys, and figures in the quantity of sewerage, the effect upon the waters of the harbors, etc. Ill. 2300 w. Eng News—March 16, 1899. No. 26554.

The Maintenance of Catch-Basins and Sewers in Providence. An article based on the quarter-century of experience in such work of the present head of the sewer maintenance force in that city. 2600 w. Eng Rec—March 25, 1899. No. 26,670.

STREETS AND PAVEMENTS.

Asphalts.

The Relative Viscosity of Asphalts and Allied Bodies. A. W. Dow. From the report of the operations of the Engineering Department of the District of Columbia for the year 1898. Describes methods of testing. 2400 w. Munic Engng—March, 1899. No. 26330 C.

Curbing.

The Proper Curbing of Streets. Horace Andrews. Abstracts of a paper written for *City Government*. Considers the disturbing forces that tend to displace the curb and means of guarding against them. Discusses material used, setting, etc. 2400 w. Stone—March, 1899. No. 26683 C.

New Orleans.

History and Selection of Street Paving in the City of New Orleans. A. C. Bell. Gives George W. Cable's description of the site and origin of the city, and reviews the progress of street-paving. 5000 w. Jour Assn of Engng Soc's—Feb., 1899. No. 26835 C.

Paris.

The Pavements of Paris. Information concerning the street pavements, which consist of stone, macadam, asphalt and wood. 800 w. U S Cons Repts, No. 380—March 22, 1899. No. 26631 D.

Paving Brick.

A New Method of Testing Paving Brick. Paper of Mr. Jones' read before the Nat. Brick Mfrs. Assn. Describes a new method of testing, aiming to reproduce the blow of the horse's foot and the rolling wear of the wagon. 2000 w. Clay Rec—March 27, 1899. No. 26566.

Methods of Testing Paving Brick. Illustrated review by W. K. Hatt, of many different tests, which he interprets as indicating the rattler test to be the only important one. 3200 w. Eng Rec—March 4, 1899. No. 26401.

The Evolution of Paving Brick in the United States. H. A. Wheeler. Read before the Nat. Brick Mfrs. Assn. Relates early experiments with paving brick in various places, its improvement and growing use. 3000 w. Clay Rec—March 27, 1899. No. 26567.

Road Construction.

See Civil Engineering, Miscellany.

Street Grades.

Establishing of Street Grades. Charles P. Chase. Discusses present practice, its advantages and disadvantages. Ill. 5500 w. Jour W Soc of Engs—Feb., 1899. No. 26834 D.

Street Grades and Cross Sections in Asphalt and Cement. A discussion of the paper by Robert P. Woods. 4400 w. Pro. Am Soc of Civ Engs—March, 1899. No. 26664 E.

WATER SUPPLY.

Duty Trial.

Duty Trial of a 30,000,000 Gallon Pump at Buffalo. Trial of a triple-expansion fly-wheel pump which gave a duty of 158.6 million foot-pounds per 1000 lbs. of dry steam. 600 w. Eng Rec—March 4, 1899. No. 26405.

Electrolysis.

Electrolysis of Cast-Iron Pipe. Harold P. Brown. An account of the condition of the pipes at Dayton, O., and the method of testing, with suggestions for protecting the mains. 3400 w. Dom Engng—March, 1899. No. 26634 C.

Filtration.

A Sand Filter-Plant. J. W. Ledoux. Full paper with discussion. Illustrated description of a plant constructed for the Berwyn Water Co., having a capacity of one and one-half million gallons per day. 4200 w. Pro of Engs' Club of Phila—March, 1899. No. 26623 D.

Sand Filtration of Public Water Supplies. R. S. Lea. Read before the Canadian Soc. of Civ. Engs. Describes the circumstances under which water supplies become polluted, and the nature of the pollution; also the process of purifying the water in large quantities by sand filtration. 13500 w. Adv Proof—Jan. 19, 1899. No. 26483 D.

The Berwyn Sand-Filter. Illustrated description of a sand-filter plant of 1,500,000 gals. daily capacity, constructed to be operated in connection with a mechanical filter plant, to determine the relative advantages of the two for the given conditions. 1200 w. Eng Rec—March 11, 1899. No. 26476.

The Cincinnati Filtration Experiments A review of experiments lasting about 8 months to determine the best method of filtering a river water carrying at times large quantities of fine silt. 5200 w. Eng Rec—March 11, 1899. No. 26475.

The Slow Sand Filtration Plant of the Berwyn, Pa., Water Co. J. W. Ledoux. Abstract of a paper read before the Engs' Club of Phila. Illustrates and describes a plant having a nominal capacity of 1,500,000 gals. per day. 1400 w. Eng News—March 9, 1899. No. 26446.

Ground Water.

The Level of Ground Water in Wells. (Grundwassenspiegel bei Brunnenanlagen.) Dr. Ph. Forchheimer. An examination of the effect of wells upon the level of subterranean water strata, especially in connection with the use of wells for extensive water supply. 2000 w. Zeit d Ver Deutscher Ing—Feb. 25, 1899. No. 26724 D.

High Service.

The New High-Service System, Lawrence, Mass. Illustrated description of works chiefly noteworthy for an enclosed standpipe, which is described in some detail. 1700 w. Eng. Rec—March 25, 1899. No. 26673.

London.

The Hydrography of the Wealden: A Possible Solution of the London Water Question. Edward F. Willoughby. The writer thinks that subsoil waters natural-

ly running to waste, may be found in sufficient quantity. 2600 w. San Rec—March 17, 1899. No. 26694 A.

New York.

Water Consumption in Greater New York. Francis L. Pruyn. Illustrated review of the available water from present sources, and the time it will take to exhaust them. 1500 w. Eng Rec—March 11, 1899. No. 26474.

Paris.

The Needs of the Water Supply of Paris. (Besoins de l'Alimentation d'Eau à Paris.) A comparison of the water supply of Paris with that of other cities, showing the necessity for an increased supply of pure water, and indicating the possible sources. 2500 w. Revue Technique—Feb. 25, 1899. No. 26713 D.

Philadelphia.

Bureau of Water, Philadelphia. Extracts from report of J. C. Trautwine, with comments. Ill. 1600 w. Fire & Water—Feb. 25, 1899. No. 26271.

Pollution.

Proposed State Legislation to Prevent Water Pollution. Editorial discussion of bills before different states. 3600 w. Eng News—March 16, 1899. No. 26555.

Pumping Engines.

A Comparison of Compound and Triple-Expansion Engines for Small Water-Works Plants. J. M. Betton. Illustrates and describes the design of the Standard Horizontal Triple-Expansion Engines, brought out by Henry R. Worthington, examining the results obtained by those now in use. 1600 w. Jour New Eng Water Wks Assn—March, 1899. No. 26688 E.

Improvement in Pumping Engines. F. F. Forbes. Reviews recent changes showing the marvelous growth in the use of engines of this class, and the results of tests. 1600 w. Jour New Eng Water Wks Assn—March, 1899. No. 26684 E.

Present Pumping Engine Practice of the Edward P. Allis Co. Compared with that of Twenty-five Years Ago. Irving H. Reynolds. An engineer's review of the causes that have brought about the great advance in economy and decrease in cost. Ill. 8800 w. Jour New Eng Water Wks Assn—March, 1899. No. 26686 E.

The Application of Gas, Gasoline and Oil Engines to Pumping Machinery. Freeman C. Coffin. Considers the general characteristics of these engines, tests, cost, etc. 3800 w. Jour New Eng Water Wks Assn—March, 1899. No. 26687 E.

The Latest Designs in Worthington Pumping Machinery, Comparing Them with the Practice of Twenty Years Ago. Charles C. Worthington. Describes the means by which the economic efficiency has been more than doubled, with but few changes in the principles of operation and details of construction. Ill. 2800 w. Jour New Eng Water Wks Assn—March, 1899. No. 26689 E.

The Possibilities of Economy in Pumping Engines as Based on the Latest Accomplishments. George H. Barrus. An examination of trials during the past five years, with a view to showing what it is reasonable to expect of the duty of a pumping engine under the best obtainable conditions. 2200 w. Jour New Eng Water Wks Assn—March, 1899. No. 26685 E.

Pumping Plant.

Deep Well Pumping Plant at Waukesha, Wis. Describes the plant and gives results and tests. 2200 w. Fire & Water—March 18, 1899. No. 26625.

The New Rockford Pumping Plant. Illustrated description of a 7,000,000 gal. plant having centrifugal pumps at the bottom of a shaft and driven by ropes from vertical engines—March 18, 1899. No. 26577.

Pumps.

A New Deep Well Pump. Illustrated description of a new form of differential water end having unusually large valve areas. 5000 w. Eng Rec—March 4, 1899. No. 26404.

Purification.

Report of the Water Purification Experiments at Cincinnati, O. A summary of work which was concluded at Cincinnati in January. Advises the adoption of the American system of clarification and purification. 2500 w. Eng News—March 9, 1899. No. 26450.

The Problem of Water Purification for the City of Philadelphia. P. J. A. Maignen. Notes the increasing daily consumption of water, and the urgent need of filtration; describes a system of sand filtration and its efficiency. Discussion. 10800 w. Pro of Engs' Club of Phila—March, 1899. No. 26622 D.

River Waters.

The Clarification of River Waters. Allen Hazen. Considers how waters become turbid and the conditions which control it, with the measures which can be taken to remove the turbidity from water supplies. 7400 w. Jour Fr Inst—March, 1899. No. 26349 D.

Standpipe.

Standpipe failure at Murphysboro, Ill. Illustrated description of the complete failure of a standpipe, 145 ft. high and 15 ft. in diameter, 15 ins. out of plumb at the time of the accident. 700 w. Eng Rec—March 18, 1899. No. 26576.

Thawing.

Thawing Frozen Pipes by Electricity. An illustrated account of the methods followed in thawing pipes up to 6 in. in diameter. 1000 w. Eng Rec—March 11, 1899. No. 26473.

Electricity for Frozen Water Pipes. Describes a method of thawing pipes by electricity used successfully in several cities. 900 w. Eng Rec—March 4, 1899. No. 26397.

Watertown, Mass.

The Transfer of the Watertown Water-Works. Describes the amicable transfer of a plant from private to public ownership. 1700 w. Eng Rec—March 18, 1899. No. 26575.

Wellesley.

Additional Water Supply of Wellesley. Describes the work of construction so successfully carried out, which consisted of driven wells connected with a suction main, and of a covered reservoir. 1300 w. Fire & Water—March 25, 1899. No. 26680.

Wells.

How Wells May Be Driven. Brief history of artesian wells and methods of boring. 1500 w. Fire & Water—March 25, 1899. No. 26679.

York, Pa.

The Water-Works of York, Pa. A description of the remarkable works built at this place in which the water was pumped 40 feet higher than needed and the reservoirs were constructed so as to be little better than sieves. 2000 w. Eng Rec—March 25, 1899. No. 26672.

Yport, France.

The Water Supply of the City of Yport. (Distribution d'Eau de la Ville d'Yport.) An interesting account of the manner in which a pure water supply was obtained for a seaport town from springs by the seashore. 300 w. 1 plate. Génie Civil—Feb. 25, 1899. No. 26704 D.

MISCELLANY.

Destructors.

The Horsfall Destructor. Abstract of report of Lord Kelvin and Professor Barr upon the tests of the Horsfall refuse destructors at Edinburgh, Bradford and Oldham. 1500 w. Engr, Lond—March 17, 1899. No. 26911 A.

Discussion.

The Cost of Municipal Enterprise. Discussion of Dixon H. Davies' paper. 14000 w. Jour Soc of Arts—Feb. 17, 1899. No. 26260 A.

Municipal Undertakings.

Municipal Notes. A review of waterworks, sewage disposal and garbage cremation undertakings during 1898, in several cities. 4200 w. Eng Rec—March 4, 1899. No. 26403.

Public Baths.

The Municipal Baths of Berlin. (Die Städt. Badeanstalteu Berlins.) An abstract of the report for 1897-98, with an account of the construction, use and management. 2500 w. Gesundheits Ingenieur—March 15, 1899. No. 26246 B.

See Architectural Engineering, Plumbing.

Refuse.

The Utilization of City Refuse. W. F. Morse. Remarks on investigations made, with a description of the plant of the Boston City Refuse Disposal Station, are given in part first. 2400 w. San—March, 1899. Serial. 1st part. No. 26355 D.

Sanitation.

A Half-Century of Sanitation. William Paul Gerhard. Read at meeting of the Brooklyn Engs' Club. Considers the progress during the second half of the nineteenth century in public sanitation and applied sanitary science. 3400 w. Am Arch—Feb. 25, 1899. Serial. 1st part. No. 26267.

History and Progress of Sanitation of the City of Washington, and the Efforts of the Medical Profession in Relation Thereto. Samuel C. Busey. Address at meeting of the Washington Academy of Sciences. A résumé of the history of sanitation in this city, covering a period of 107 years. 4500 w. San—March, 1899. No. 26353 D.

Trading.

Municipal Trading. Editorial discussion of this subject as viewed in England, and of some of the difficulties in the distribution of profits and losses. 2200 w. Engr, Lond—March 10, 1899. No. 26,603 A.

Municipal Trading. The first of a series of articles discussing conditions in England which have led to the development of municipal trading, and the measure of success which has thus far attended the practice. 1800 w. Jour Gas Lgt—Feb. 28, 1899. Serial. 1st part. No. 26425.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in 1898. Tabulated summary of the year's accidents, with comments. 1000 w. R R Gaz—March 10, 1899. No. 26458.

Train Accidents in the United States in January. Detailed list with classified summary, and an editorial on "Emergency Single-Track Blocking," discussing the butting collision at West Dunellen, N. J. 3400 w. R R Gaz—March 24, 1899. No. 26655.

Japan.

Japanese Railways. C. Kadono. Read before the Japan Society in London. The history, present state and future prospects of the railways, with description of the important lines. 2600 w. Engr, Lond—March 3, 1899. No. 26529 A.

Light Railroad.

Note on the Operation of a Light Mineral Railroad. James Douglas. Statistics of the Arizona Southeastern Railroad. 1400 w. Trans Am Inst of Min Engs—Oct., 1898. No. 26253 D.

Russia.

Railway Traveling in Russia. From *Railroad Men.* An interesting account of conveniences furnished for night travel, and of manners and customs of the country. 2200 w. R R Car Jour—March, 1899. No. 26500.

FINANCIAL.

Australasia.

The Cost of the Australasian Railways. Editorial remarks on the information furnished by Mr. Price Howell to the Royal Statistical Soc. 1400 w. Engng—Feb., 24, 1899. No. 26369 A.

Earnings.

Decreased Railroad Earnings in February. Gives a record of the month named, discussing causes, and giving comparison with preceding periods. 700 w. Bradstreet's—March 11, 1899. No. 26,465.

India.

The East Coast State Railway. S. R. E. Observations on the present situation, analyzing the financial results so far obtained. 1000 w. Ind Engng—Jan. 28, 1899. No. 26339 D.

Operating Expenses.

A Method of Examining Operating Expenses. J. Shirley Easton. Suggestions for making expense returns, with explanations. 3400 w. R R Gaz—March 17, 1899. Serial. 1st part. No. 26559.

LEGAL.

Pooling.

The Opposition toRailway Pooling. H. T. Newcomb. Discusses the question of competition among railways, and the facts and arguments which have favored the re-establishment of the pooling system, with the causes that have prevented effective legislation. 5500 w. N Am Rev—March. 1899. No. 26326 D.

Swiss Railways.

The Regulation and Nationalization of the Swiss Raiways. Hans Dietler. Part first reviews the development of the rail ways, and the legislation affecting them up to 1872. 9400 w. An Am Acad—March, 1899. Serial. 1st part. No. 26536 F.

MOTIVE POWER AND EQUIPMENT.

Brakes.

Air Supply and Demand in Freight Service. Substance of a paper presented at the Northwest Ry. Club. On the necessity of increasing the air-supply, and the economy of maintaining air pumps in first-class condition. 3300 w. Ry & Engng Rev—March 25, 1899. No. 26814.

Air Supply and Demand in Freight Service. From a report of the committee of the Northwest Ry. Club, showing that under severe conditions in freight train service the air supply is deficient, and recommending the use of large pumps and stopping the leaks. 1200 w. R R Gaz—March 10, 1899. No. 26455.

A Yard Installation for Testing Air Brakes. Illustrates and describes the plant at West Freight Yard, Wilmington, Del. 600 w. R R Gaz—March 24, 1899. No. 26654.

Inspection and Care of Air Brakes. Describes the practice of the Lake Shore & Michigan Southern Railway, at Buffalo, N. Y. 1500 w. Am Eng & R R Jour—March, 1899. No. 26300 C.

Brake Shoes.

Tests of the Corning Brake Shoe. Report of laboratory tests recently made by Prof. Goss, at Purdue Univ., to determine the frictional qualities. 700 w. R R Gaz—March 24, 1899. No. 26657.

Car Heating.

Note on the Status of Car Heating. (Note sur la Situation der Chauffage des Trains.) MM. Pfitzinger and Mauclére. A very full review of the construction and operation of apparatus for heating railway carriages in Germany, Austria and Switzerland during the winter of 1897-98. Two articles. 12000 w. 9 plates. Rev Gen des Chemins de Fer—Feb., March, 1899. No. 26757 each F.

Car Lighting.

The Electric Lighting of the Prussian Railway Mail Cars. (Die Elektrische Beleuchtung der Preussischen Bahnpostwagen.) F. Milius. Storage batteries and incandescent lamps are used, about two-thirds of the mail cars in Prussia now being lighted by electricity. 1500 w. Elektro-Techniker—Feb. 15, 1899. No. 26783 B.

Corridor.

The Great Central New Corridor Trains. Illustrates and describes the rolling stock of the new line of the Great Central Ry. Co., England. 1600 w. Engr, Lond—March 10, 1899. No. 26600 A.

Couplers.

The Computation of the Strength of Bent Prismatic Bodies. (Zur Frage der Berechnung Gekrümmter "Stabförmiger Korper.) A Bantlin. A discussion of the

strength of hooks used for coupling railway carriages; based upon Föppl's experiments at the Charlottenburg testing laboratory. 2000 w. Zeit d Ver Deutscher Ing —March 11, 1899. No. 26728 D.

The M. C. B. Coupler—Its History and its Performance in Service. William Garstang. An interesting review giving as a result of the researches, the opinion that the M. C. B. coupler, as adopted, is the best device for the purpose that has been presented to the railroad companies. 3000 w. R R Gaz—March 10, 1899. No. 26452.

Electric Locomotives.

Electric Driving on Main Line Railways. (Uber Elektrischen Betrieb auf Vollbahnen.) C. P. Feldman. An important discussion of the requirements and possibiities of electric traction as appied to main line service. 7000 w. Zeit d Ver Deutscher Ing—Feb. 18, 1899. No. 26722 D.

Framing.

Car Framing. C. A. Seley. A discussion of the theories of F. M. Whyte, as set forth in a recent paper, with the writer's views. 1800 w. Am Eng & R R Jour—March, 1899. No. 26299 C.

Gondola Car.

80,000 lbs. Capacity Gondola Car for the Lake Terminal Railroad. Engravings, showing the principal features, with particulars. 600 w. R R Gaz—March 31, 1899. No. 26837.

Headlights.

Acetylene Gas for Locomotive Headlights. Illustrated description of an acetylene gas generator as applied to locomotives. The device was invented by A. M. Holland, of Ottawa, Canada. 1000 w. Ry and Engng Rev—March 4, 1899. No. 26414.

Locomotive Attachment.

Attachment for Locomotives, (Dispositif Applicable aux Locomotives.) A description of an electrical attachment for setting the brakes and reversing the engine automatically. 2500 w. Revue Technique—March 10, 1899. No. 26718 D.

Locomotives.

A Heavy Geared Locomotive. Illustrates a large geared engine recently built for the St. Paul & Tacoula Lumber Co., giving dimensions. 600 w. Eng News—March 9, 1899. No. 26448.

Ancient Locomotive Engines. Herbert T. Walker. Illustrates and describes three early English locomotives. 1500 w. Sci Am—March 18, 1899. No. 26547.

A New High Speed Locomotive. From *Le Génie Civil*. Illustrates and describes a proposed engine capable of maintaining a speed of 72 miles an hour. 800 w. Sci Am Sup—April 1, 1899. No. 26820.

British Locomotives in 1898. Illustrations with descriptions taken from an article by Mr. Charles Rous-Marten. 1800 w. Transport—March 3, 1899. No. 26508 A.

Consolidation Locomotive with Large Drivers for the Lehigh Valley Railroad. Illustrated description of an engine which is a departure from the usual practice. 350 w. R R Gaz—March 10, 1899. No. 26456.

Eight-Wheel, Class H, Passenger Locomotive—Wabash Railroad. Principal general dimensions with illustration. 500 w. R R Gaz—March 24, 1899. No. 26656.

Express Passenger Engine, Lancashire and Yorkshire Railway. Sections, with principal dimensions of the most powerful inside-cylinder passenger locomotive in England. 1500 w. Engr, Lond—March 17, 1899. No. 26807 A.

Schenectady Moguls for the Southern Pacific. Engraving and descriptive specifications. 350 w. R R Gaz—March 31, 1899. No. 26836.

Ten-Wheeled Passenger Locomotive. Buffalo, Rochester & Pittsburg Ry. Illustrations, particulars, and general dimensions. 500 w. Eng News—March 23, 1899. No. 26645.

The "Atlantic Type" Locomotive in Germany. General description, translated from an article by Mr. von Borries. Ill. 600 w. R R Gaz—March 17, 1899. No. 26562.

The New Compound Locomotives of the Central Railway of France. (Les Nouvelles Locomotives Compound de la Compagnie du Midi.) With outline diagrams of these new compound locomotives, and a comparison with the engines of the Northern Railway of France. 2000 w. Revue Technique—Feb. 25, 1899. No. 26714 D.

Types of Russian Locomotives. Nicholas Smirnoff. Illustrates and describes the locomotives of the St. Petersburg and Warsaw Railway. 400 w. Loc Engng—March, 1899. No. 26347 C.

Resistance.

A New Formula for Train Resistance. Editorial discussion of a new formula by John Lundie, given in the *Street Railway Journal*. 1100 w. Engr, Lond—Feb. 17, 1899. No. 26217 A.

A New Train Resistance Formula. Comment on the Lundie formula published in the *Street Railway Journal*. 1700 w. Loc Engng—March, 1899. No. 26348 C.

A New Train Resistance Formula. Mr. Lundie's formula, as given in the *Street Railway Journal*, with editorial comment. 2200 w. Ry Mas Mech—March, 1899. No. 26407.

The Baldwin Train Resistance Formula. An account of the Baldwin trials and deductions on which the formula was based.

800 w. R R Gaz—March 17, 1899. No. 26558.

The Resistance of Loaded and Empty Freight Cars. Gives results of some interesting dynamometer tests made a few years ago, which show the relation between loaded, partially loaded and empty freight cars. Also editorial. 1800 w. R R Gaz—March 24, 1899. No. 26658.

Train Resistance. John Balch Blood. Criticises methods used by Mr. Lundie, and gives calculations made by the writer and other tests. Also a number of letters to the editor in regard to the Lundie formula. 4500 w. St Ry Jour—March, 1899. No. 26416 D.

Sleeping Cars.

Sleeping Cars for the Florida East Coast Railway. Illustrated description of luxurious cars recently built. 900 w. R R Car Jour—March, 1899. No. 26499.

Special Car.

A Car with Depressed Platform. (Note sur un Wagon à Plateforme Surbaissée.) M. J. Koechlin. A description, with detail drawings, of a special car with the bottom depressed as low as possible, to permit large pieces of machinery to be shipped. 250 w. 2 plates. Rev. Gen des Chemins de Fer—March, 1899. No. 26,758 F.

NEW PROJECTS.

Africa.

From Djibouti to Harrar. From *Le Monde Illustré.* Illustrations with particulars concerning this section of the road. 1700 w. Sci Am Sup—March 4, 1899. No. 26292.

Australia.

Railways in Western Australia. Notes the difficulties met and the wisdom of the policy adopted, giving information concerning these railways. 1200 w. Engng—Feb. 17, 1899. No. 26223 A.

Canadian Railroads.

Canadian Railroad Building, Recent and Prospective. Detailed account of work in Manitoba, British Columbia, and extensions and improvements in general. 1800 w. R R Gaz—March 31, 1899. No. 26840.

Extensions.

Railways in Burma and Their Proposed Extension Across Yunnan. John Nisbet. Discusses the proposal to extend the railway now being constructed to the eastward, concluding that the present prospect of trade does not warrant the expense. Also general discussion. Map. 13000 w. Jour Soc of Arts—Jan. 27, 1899. No. 26489 A.

Intercontinental.

The Inter-Continental Railroad. Editorial on the work of the Commission and their recently issued report. 1500 w. R R Gaz—March 3, 1899. No. 26323.

The Railway Systems of Central and South America. An abstract of the report of the Inter-continental Ry. Commission, showing the principal technical features and giving an account of the surveys. Ill. 6000 w. Eng News—March 23, 1899. No. 26642.

Soudan Railways.

The Railways of the French Soudan. From *Le Monde Illustre.* Gives a list of projected and completed railways, and some particulars and illustrations. 600 w. Sci Am Sup—Feb. 4, 1899. No. 25698.

Transcaspian.

The Transcaspian Railway. Alexis Krausse, in *Black and White.* Describes and illustrates this railway, constructed by Russian engineers over a country which is mostly a sandy desert. It has engineering features of special interest. 1800 w. Sci Am Sup—March 11, 1899. No. 26434.

Tunis.

The Construction of the Railway from Sfax to Gafsa. (Construction du Chemin de Fer de Sfax a Gafsa.) L. Rey. An account of the construction of a railway in Tunis for the exploitation of the phosphate deposits. Steel sleepers are used, the track being laid in sections. 2500 w. Soc Ing Civ de France—Dec., 1898. No. 26025 F.

PERMANENT WAY AND FIXTURES.

Boston Terminal.

The New South Terminal Station in Boston and its Effect on Traffic Conditions in Eastern Massachusetts. An interesting article giving a brief description of this new station with its peculiarities, and discussing its influences on transportation conditions. Ill. 2800 w. St Ry Jour—March, 1899. No. 26418 D.

Early Railroading.

Some Railroaders of 1850. Walter S. Phelps. A brief account of early railroading and of the first frog devised for the Milwaukee & Mississippi. 800 w. R R Gaz—March 24, 1899. No. 26653.

Frogs.

Formulas for Locating Frogs. Malverd A. Howe. Gives a method for locating a given frog requiring only a few simple formulas f ll the cases that ordinarily occur. 400 w. R R Gaz—March 10, 1899. No. 26454.

Masonry.

Expansion Joints for Retaining Walls on the St. Charles Air Line Ry., Chicago. Describes a novel feature introduced in the construction, which is of interest to engineers. 450 w. Eng News—March 9, 1899. No. 26445.

Paris.

The Railway from Courceles to Passy. (Le Chemin de Fer de Courcelles à

Passy.) A description of the extension of this local railway to the Champ de Mars, with details of work on tunnel and bridges. 2500 w. Revue Technique—March 10, 1899. No. 26717 D.

Permanent Track.

Permanent Way for Steam Railways. Letters crticising features of designs suggested in recent paper of J. W. Schaub, and presenting other plans for improvement. Ill. 4000 w. Eng News—March 23, 1899. No. 26644.

Rail Joints.

Bridge Rail-Joints. (Stossfugenüberbrückung.) Dr. Zimmerman. A discussion before the German Railway Society, of the recent paper by Dr. Vietor, with especial reference to the influence of impact upon the rails and joints. 5000 w. Glaser's Annalen—March 1, 1899. No. 26734 D.

Rail-Sections.

Important Results Obtained in the Past Fifteen Years with the Stiff and Heavy Rail-Sections. P. H. Dudley. Reviews the results secured on various roads, and the progress made in railway engineering. 4500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26484 D.

Rail Trimming.

Rail Trimming on the Michigan Central and Santa Fe Roads. An illustrated detailed description of one of the plants engaged in the work of rail-trimming. 2500 w. Ry and Engng Rev—March 4, 1899. No. 26412.

Shed.

The Temporary Shed over the New Lyons Railway Station. (La Charpente-Abri de la Nouvelle Gare de Lyon.) An illustrated account of the temporary structure erected to protect the works of a new railway station in Paris, also describing the traveling cranes and erecting plant. 2000 w. Génie Civil—March 4, 1899. No. 26705 D.

Signals.

Automatic Block Signals on the Southern Pacific at Los Angeles. Brief description of automatic semaphore block signals worked by electric motors. 350 w. R R Gaz—March 17, 1899. No. 26563.

Electric Block Signals in Austro-Hungary. (Die Electrischen Blocksignale in Oesterreich-Ungarn.) L. Kohlfürst. A detailed description of the systems used on the Austrian State railways, with diagrams. 2000 w. Elektro-Techniker—Feb. 28, 1899. No. 26784 B.

Inspection of Automatic Block Signals. Comments by G. W. Blodgett, with editorial. 2800 w. R R Gaz—March 17, 1899. No. 26560.

The Arrangement of Electric Railway-Signals. (Dispositif Electrique Applicable aux Signaux de Chemins de Fer.) A description of an improved system of electrical control adapted to be used with the signal systems at present in use on the French railways. 2500 w. La Revue Technique—Feb. 25, 1899. No. 26712 D.

The Closing of Block Signals by Electric Switch Connections. (Ueber den Anschlurs von Stellwerksanlagen mit Elektrischem Weichenstrassen-Verschlusse an Blocklinien.) Martin Boda. An elaborate analysis of electric block signals as applied to the railways of Austro-Hungary. 6000 w. Zeit d Oesterr Ing u Arch Ver—Feb. 17, 1899. No. 26730 B.

Sleepers.

The Computation of Cross-Tie Structures. (Beitrag zur Berechnung des Querschwellen oberbanes.) Prof. Skibinski. A very complete mathematical discussion of the stresses in railway sleepers, with numerous diagrams and tables, both for metal and wooden sleepers. Two articles. 9000 w. Zeit d Oesterr Ing u Arch Ver—Feb, 24, March 3, 1899. No. 26732, each B.

Terminal.

The New Terminal of the Orleans Railway at the Quai d' Orsay. Jacques Boyer. A handsomely illustrated account of the important terminal works now in construction, which will bring the Orleans railway into the heart of Paris. 5000 w. Engineering Magazine—April, 1899. No. 26819 B.

The Prolongation of the Orleans Railway. (Prolongement de la Ligne d'Orléans.) Describing especially the use of the shield in connection with the tunnelling under the quai de la Tournelle. 3500 w. 1 plate. Génie Civil—Feb. 11, 1899. No. 26700 D.

Trans-Siberian.

The Trans-Siberian Railway. (La Ferrovia Transiberiana.) E. Pattacini. A general review of the routes of the various sections of the road, with data as to time and cost of construction and statements of the present condition of the work. Serial. Part 1. 2000 w. Gior d Lav Pubb e d Str Ferrate—Feb. 8, 1899. No. 26789 D.

TRAFFIC.

Car Hire.

The Settlement of Car Hire Accounts on Per Diem or Mileage Basis. J. M. Daly. A discussion of the irregularities of the mileage plan, and favoring the per-diem basis. Discussion by members. 15000 w. N Y R R Club—Feb. 16, 1899. No. 26618.

Freight.

Freight Transferring. C. W. Nash. Notes the steps recently taken to improve the handling of freight, describing the method as conducted at the railroad department of the D & H. C. C., at Mechanicsville, N. Y. 1100 w. Ry and En-

gng Rev—Feb. 25, 1899. Serial. 1st part. No. 26278.

Freight Loading System at Richmond, Va. Edwin H. Lea. Describes in detail a system that has been working satisfactorily for ten years. 2300 w. R R Gaz—March 24, 1899. No. 26659.

Italy.

Notes on the Railways in the Valley of the Tiber. (Considerazioni Sulla Ferrovia in Valle Tiberina.) A review of the railways of central Italy, and the connections necessary to unite them more effectively with the main lines of Italy and Central Europe. 3000 w. Gior d Lav Pubb e d Str Ferrate—Feb. 22, 1899. No. 26790 D.

St. Gothard.

The Operation of the St. Gothard Railway in 1897. (Résultats de l'Exploitation de Chemin de Fer du Saint Gothard pendant l'Année 1897.) Jules Michel. A general examination of the traffic between Italy and Switzerland, with diagrams showing the growth of various branches of the service since 1883. 3500 w. Rev Gen des Chemins de Fer—Feb. 1899. No. 26755 F.

Ticket Scalping.

The Ethics of Ticket Scalping, A discussion of scalping from the economic and the moral points of view. 3700 w. Gunton's Mag—March, 1899. No. 26359 C.

Transport Charges.

The Commercial Meaning of Transport Charges. (Ueber die Wirthschaftliche Bedeutung der Gütertarife.) Bergrath Gothein. An address delivered before the Silesian ironmasters, discussing especially the relations of railway charges to the coal mining industry. 4500 w. Stahl und Eisen—Jan. 1, 1899. No. 26039 D.

STREET AND ELECTRIC TRAMWAYS

Air Brakes.

The Standard Air Brake for Street Cars. Illustrates and describes the brakes that are to be applied to the 160 cars now being built for the electric service of the Third Avenue Railroad in New York City. 1700 w. R R Gaz—March 31, 1899. No. 26838.

Blackburn.

Electric Tramways at Blackburn. Illustrated detailed description of an English plant. 2500 w. Elec Eng, Lond—March 17, 1899. No. 26800 A.

Cable.

The Electric Cable-Road at Mont-Dore. (Die Elektrisch Betriebene Seilbergbahn in Mont-Dore.) A three-phase current operates a motor which hauls the cars to the top of the incline by a cable. The power is derived from a hydraulic station in the valley 1¼ miles distant. 2000 w. Elektrotech Zeitschr—Feb. 23, 1899. No. 26764 B.

Construction.

Some Details of Street Railway Construction. W. H. Rosencrans. Describes the lines in and about South Bend, Ind. Ill. 1700 w. Munic Engng—March, 1899. No. 26328 C.

Development.

Electric Tramway Development. Editorial discussion of the development in England and the points needing special attention. 1800 w. Engr, Lond—March 3, 1899. No. 26527 A.

Double-Track.

Double-Track Electric Railway from Butte to Centerville, Montana. Francis W. Blackford. Particulars concerning the change made from cable to electric traction. Ill. 700 w. Jour Assn of Engng Soc's—Jan., 1899. No. 26333 C.

Electric Locomotives.

See Railway Affairs, Motive Power.

Electrolysis.

See Municipal Engineering, Water Supply.

Equipment.

Power and Equipment of Electric Railways. H. H. Hunt and C. K. Stearns. Reviews the events that mark the progress of the application of electricity to street car propulsion, and outlines the problems in design, and the method of treatment. 5600 w. Jour Assn of Engng Soc's—Jan., 1899. No. 26332 C.

Interurban.

The Dayton and Western Interurban. Illustrates and describes an interurban road extending 25 miles west of Dayton, O., as an example of latest practice. 1200 w. St Ry Rev—March 15. 1899. No. 26627 C.

Lawsuit.

Legal Victory for the Aurora & Geneva Railway. Discusses the decision of the Illinois Supreme Court in regard to the right of an interurban electric railway to leave the highway and condemn a right of way through private property. Gives a detailed statement of the facts and circumstances. 7200 w. St Ry Rev—March 15, 1899. No. 26626 C.

Loop.

The Chicago Elevated Loop. Henry M. Sperry. Brief illustrated description of the loop and stations is given in part first. 1100 w. R R Gaz—March 17, 1899. Serial. 1st part. No. 26561.

Monaco.

The Electric Tramway at Monaco. (Die Elektrische Strassenbahn in Monaco.) An interesting installation of the point-contact system, with illustrations of the work in construction and after completion. 1500 w. Ill. Zeitschr f Klein u Strassenbahnen—Feb. 1, 1899. No. 26787 D.

Mountain Roads.

Mountain Electric Railways. W. L. Hedenberg. Reviews some of the early attempts to climb mountains by mechanical means, describing and illustrating some of the electrically operated roads. 2500 w. Elec, N. Y.—March 22, 1899. No. 26637.

Pittsburg.

New Power Station, Repair Shops and Car Houses of the Consolidated Traction Company of Pittsburg. An illustrated study of the reconstructed. system of this company, which presents many interesting features. 8400 w. St Ry Jour—March, 1899. No. 26415 D.

Power Station.

Power Station of the Market Street, Railway Company, San Francisco, Cal. Illustrates and describes the station supplying current for the operation of the electric system. 700 w. Power—March, 1899. No. 26297.

Rail.

New Girder Rail of the General Omnibus Company of Paris. (Nouveau Rail-Poutre de la Compagnie Générale des Omnibus de Paris.) M. Delonchant. With sections of rails and joints, and drawings of fish plates. 1000 w. Rev. Gen des Chemins de Fer—Feb., 1899. No. 26,-756 F.

Rail-Bonding.

The Electrical Connection of Tramway Rails. (Connexion Electrique des Rails de Tramways.) Ch. Thonet. A report presented at the Geneva meeting of the International Union of Tramways, reviewing the principal methods of rail-bonding employed in Europe and America. Two articles. 3000 w. L'Electricien—March 11, 18, 1899. No. 26777, each B.

Rapid Transit.

Rapid Transit in New York City. Editorial on the proposition of the Metropolitan Street Railway Company to build and operate the tunnel railroad which the Commissioners have long been trying to get built. 1200 w. R R Gaz—March 31, 1899. No. 26839.

Return Feeders.

Return Feeders for Electric Railways. Translation of article by Br. Böhm-Roffay, in *Elektrotechnischer Neuigkeits-Anzeiger*, giving simple formulæ, or graphical methods of determining the section and volume of the return feeders. 1800 w. Elec Rev, Lond—March 3, 1899. Serial. 1st part. No. 26514 A.

Stray Currents.

See Electrical Engineering, Measurement.

Traction.

Commercial Aspects of Electrical Traction in Great Britain. Emile Garcke. A discussion of present conditions, showing how onerous conditions and municipalizing tendencies have hampered the progress which might otherwise have been made. 5000 w. Engineering Mgaazine—April, 1899. No. 26818 B.

Electric Traction by Surface Contacts. Miles Walker. Read before the Brit. Inst. of Elec. Engs. Discusses whether a surface-contact system can be laid so as to cause no obstruction to traffic; whether picking up current from studs by means of a skate is feasible under practical working conditions, and whether the studs can be made perfectly safe. Ill. 3800 w. Ind and Ir—Feb. 17, 1899. Serial. 1st part. No. 26228 A.

Traction by Electrical Power. A. C. Elliott. Read before the Inst. of Marine Engs. Brief review of the various systems. 2500 w. Prac Engr—Feb. 17, 1899. No. 26229 A.

Traveling Platform.

Electric Transportation at the Exposition of 1900. (Les Transports Electriques de l'Exposition de 1900.) An account of the tests made upon the trial platform submitted by M. de Mocomble for the Exposition; with numerous illustrations. 1800 w. 1 plate. Génie Civil—Feb. 18, 1899. No. 26702 D.

Underground.

Building an Underground Railway. Abstract of a lecture by Basil Mott, giving a description of the construction of the Central London Railway. 1800 w. Builder—Feb. 18, 1899. No. 26205 A.

The Future of the "Underground" Railway. George Frederick Bird. Discusses the series of experiments being undertaken with the object of adopting electric traction and outlines a scheme for rendering more efficient service and overcoming the objectional features. 4500 w. Engr, Lond—Feb. 3, 1899. No. 25919 A.

The Passy Underground Railroad. From *La Nature*. Interesting particulars of the construction work. Ill. 1800 w. Sci Am Sup—March 25, 1899. No. 26639.

The Underground Railway of Boston. Jane A. Stewart. An illustrated account of this successful undertaking, and the relief it has proved to the congested traffic of the city. 3000 w. Chau—March, 1899. No. 26281 C.

Book Reviews

THE AUTOMOTOR AND HORSELESS VEHICLE POCKET BOOK. London: P. King & Co., Ltd., 1899.

In the first place, we notice that the present edition of 271 pages has increased from 212 pages in 1898, and that the amount of advertising has nearly doubled. All of the useful matter which was in the previous edition has been retained in the present one and much of importance has been added. The compiler says in his preface "That the former issues of this work have met a distinct want on the part of those engaged in the Moto-Vehicle industry is shown by the fact that every copy of them has been sold." We are not surprised to learn this for there was and is need of such a pocket book, and this is one which compares favorably with any of any of its fellows in any class.

THE TRACTION ENGINE. Its Use and Abuse. By James H. Maggard. Philadelphia: David McKay, Publisher.

This little book is a well written one and treats of a subject which is of constantly increasing importance. The dangerous expedient is adopted of a supposedly intimate conversation between the writer and the reader, but the plan has been carried out with entire success and without ever falling into the vulgarities and commonplaces which are so frequent in works of the kind. Every word tells, and the peculiarities of form are soon lost sight of in the clearness of the language and the continuity of the narrative. If there is a fault, it is in the quality of and the limited number of the engravings. We heartily recommend the book to anyone, whether experienced or not, having much to do with traction engines.

THE COFFER DAM PROCESS FOR PIERS. By Charles Evan Fowler, Mem. Am. Soc. Civ. Engrs. New York: John Wiley & Sons, 1899.

This is one of the books which, once taken up, it is hard to lay down before it is finished without at least forming a resolution to return to it soon. Not that it presents anything particularly new, strange or startling, but because what it does give, is so unusually well given. There is here collected a mass of information which is of the highest value to a civil engineer, particularly a young one, and which it is doubtful if he could secure in any other way except by doing the very work that the author has been forced to perform in preparing the book for the press.

A short but interesting chapter on the history of foundations opens the work. This is followed, in the order given, by Construction and Practice, Pile Driving and Sheet Piles, Construction with Sheet Piles, Metal Construction, Pumping and Dredging, The Foundation, Location and Design of Piers. An Appendix devoted to specifications for different kinds of work, together with a very good index, concludes the book. The illustrations, 104 in number, are of a high order and accomplish the purpose for which they were intended.

HANDBOOK OF METALLURGY. By Dr. Carl Schnabel. Translated by Henry Louis, M. A. Two Volumes. London: Macmillan & Co., Limited. New York: The Macmillan Co., 1898.

The appearance of an English translation of Dr. Schnabel's treatise on metallurgy goes a long way towards filling an important gap in technical literature. Many years ago the late Dr. Percy commenced the publication of his monumental work on metallurgy, with the intention of devoting an entire volume to each metal, these being preceded by a volume on Fuel, but this great work remains a fragment, and new processes and methods have in the meantime come into use.

Dr. Schnabel's work, of which the first volume originally appeared in 1894, and the second two years later, makes no pretensions to the elaborate completeness of Dr. Percy's treatises, but bears the more modest name of "handbook," although the condensed style and compact make-up of the handsome volumes permits a very full treatment of the modern methods which are employed in actual practice. With this

is given a concise statement of the scientific principles underlying the methods employed, the whole forming a general treatise on metallurgy amply sufficient for the needs of the student.

Although the work is entitled a handbook of metallurgy, its contents are really limited to the narrower field implied by this title in Germany, there being nothing in the treatise about the metals of the iron group. This is doubtless a wise provision, both because of the magnitude of this omitted branch, and because of the existence of other treatises which fill the gap.

The entire first volume is devoted to the four metals, copper, lead, silver and gold, and forms the most important portion of the work. Here are gathered, in a necessarily condensed form, illustrated descriptions of the methods and processes in use for the extraction of the metals named, including the later methods of gold extraction, as applied in South Africa and elsewhere, Mr. Louis here having supplemented Dr. Schnabel by the later information gathered since the publication of the German original, including data concerning electrolytic methods.

In the second volume are given the methods of smelting zinc, cadmium, mercury, bismuth, tin, antimony, arsenic, nickel, cobalt, platinum and aluminum, more than one-third of the volume being devoted to zinc. A very full discussion of the electrolytic method of extracting zinc is given, including both the direct extraction from the ore, and also the electrolytic separation from alloys, this forming one of the most valuable portions of the whole treatise. Mercury is also given a very full treatment, the methods employed at Idria, Almaden and New Almaden being illustrated and described at length. Aluminum is hardly given so full a treatment as its growing importance would seem to warrant, but this may be due to the fact that separate treatises are available entirely devoted to the subject. Nickel and tin are given excellent discussions, and in general, the work in both volumes is of the high character which might be expected from the names of the author and translator.

In one respect especially, the work demands high praise, i. e., in the completeness of the index. Not only is there a very full general index, but this is preceded by a geographical index of equal completeness, so that not only may any subject be readily found in the usual manner, but all the references to any locality are grouped in the geographical index under the name of the place, a most admirable idea, and worthy of imitation in other works of this kind.

The typography and illustrations of the volumes are most excellent, and the work will doubtless become a standard textbook in many places.

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J. Rhodes & Sons, Wakefield, Yorkshire, England.—*(a)* Illustrated and descriptive catalogue of presses, dies and special machines for working sheet metals and wire, with full index; *(b)* price list of machines described in above catalogue.

Wright's Patent Heater Condenser Company, Great George St. Chambers, London, S. W.—Pamphlet by Mr. Howard Wright describing the softening and purification of water according to the firm's system. Illustrated.

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Kelley Island Lime and Transport Company, Cleveland, Ohio, U. S. A.—Catalogue of the Lägerdorfer high grade Portland cement, giving data of tests and many illustrations of important constructions in the United States in which this cement has been used.

The Ingersoll-Sergeant Drill Company, New York—Catalogue No. 41, containing descriptions, illustrations and specifications of mining, tunnelling and quarrying machinery, including much useful information upon these subjects of value to the engineer and contractor.

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Joseph Wright & Co., Tipton, Staffs., England.—Price list and catalogue of feed water heaters, surface and evaporative condensers, grease filters, water softeners, etc. Also of wagon and tram couplings, chains, anchors and other forgings.

Sir Theodore Fry & Co., Rose Carr Rolling Mills, Darlington, England.—Section book in cloth cover of iron and steel bars and rails and special sections for wagon makers and other trades.

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Rand Drill Company, New York.—Handsomely illustrated catalogue (D) of rock drills and drill mountings for mines, quarries and tunnels, with interesting historical matter, referring to important works upon which the Rand drills have been used.

B. F. Sturtevant Company, Boston, Mass., U. S. A.—Catalogue No. 96, devoted to the special subject of steel-plate fans, showing designs for a

wide variety of applications and specifications of dimensions and capacities. A number of valuable tables for consultation in connection with the movement of air are appended.

Gandy Belt Manufacturing Company, Ltd., Seacombe, Cheshire, England.—Illustrated price lists of *(a)* belting and hose of several varieties; *(b)* the Dodge wood split pulley.

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The Conduit and Insulation Company, Ltd., 63 Queen Victoria St., London, E. C.—*(a)* Price list of steel armored insulating conduit and accessories; *(b)* two pamphlets written by Mr. F. Bathurst dealing with "Electric Wiring Practice" and the "Prevention of Fire Due to Leakage of Electricity."

The New Incandescent Gas Lighting Co., Ltd., 33 Shoe Lane, London.—Large illustrated price list of incandescent burners, lamps, globes, pendants and other lighting requisites.

Isaac Hill & Son, St. George's Engineering Works, Derby, England.—Illustrated catalogue of cold sawing machinery; also of machines for sawing hot iron castings, etc., with long list of testimonials.

Loring Coes & Co., Worcester, Mass., U. S. A.—Catalogue of machine knives for wood-working machinery, leather-splitting machines, paper cutters, agricultural machinery, &c., describing the application of concave grinding and of "pyrocalcic" tempering, and showing the high degree of precision which has been attained in this class of work.

Almy Water-Tube Boiler Company, Providence, R. I., U. S. A.—General catalogue of the Almy sectional water-tube boiler, with especial reference to its application to marine service, as well as to stationary practice.

The Risdon Iron Works, San Francisco, Cal. U. S. A.—*(a)* Catalogue No. 12, of milling machinery for use in the treatment of gold, silver, copper, lead and other ores; *(b)* Catalogue No. 5, describing the Evans hydraulic elevator and other hydraulic mining machinery; *(c)* Catalogue No. 17, devoted to gold dredging machinery, with numerous examples of the system of dredging river beds for gold.

McLachlan & Co., Haughton Bridge Works, Darlington, England.—Illustrated catalogue of railway wagons and mining tubs, built in either wood or steel, and for side, end or all round tipping.

Gresham & Craven, Ltd., Ordsall Lane, Manchester, England.—Catalogue of injectors and other specialties for railway work, handsomely illustrated in half-tone. Devices for sanding and carriage warming and hose couplings are also described.

Société Anonyme des Forges, Usines et Fonderies de Gilly, Gilly, Belgium.—*(a)* Illustrated catalogue of steam hammers and briquette making machinery; *(b)* series of sheets with sectional views of locomotives with particulars.

Thwaites Brothers, Vulcan Iron Works, Bradford, England.—Pamphlet describing Stewart's patent cupola, and other foundry plant.

Geo. Richards & Co., Ltd., Broadheath, Manchester, England.—Illustrated catalogue of woodworking machinery.

American Hard Rubber Company, New York.—Catalogue of hard-rubber pumps, pipes and fittings, adapted for the pumping and conveyance of acids, salt water or other liquids with which contact with metal is objectionable.

Westinghouse, Church, Kerr & Co., New York.—"A Few Words About Mechanical Stokers," being a very handsome pamphlet descriptive of the construction and performance of the new Roney mechanical stoker as applied to steam boilers; showing the advantages of mechanical stoking in regard to economy, smokelessness, adaptability of low-grade fuels, and general efficiency of steam plants. Illustrations of numerous large installations are given.

The Wilkinson Manufacturing Company, Philadelphia, Pa., U. S. A.—Catalogue of the Wilkinson automatic stoker, showing the construction and operation of the device, together with numerous testimonials and illustrations of many large buildings and manufacturing establishments using the stoker.

The Watson-Stillman Company, New York.—Illustrated index of hydraulic tools and miscellaneous machinery, forming Catalogue No. 51, and consisting entirely of miniature illustrations of the various machines, with their names and reference numbers to detailed sheets.

A. Ransome & Co., Ltd., Stanley Works, Chelsea, London.—*(a)* Large illustrated catalogue of wood working machinery in great variety with full descriptions and code words. Among the new machines may be mentioned some log band sawing machines, a rack circular saw bench with supplementary top saw and a crosscut saw for hard wood paving blocks; *(b)* price list of machines described in above catalogue

Cowans, Sheldon & Co., Ltd., St. Nicholas Works, Carlisle, England.—Illustrated cloth-bound catalogue and price list of lifting machinery and railway plant, principally describing cranes, turntables, water columns, etc. Very fully coded.

The Brush Electrical Engineering Company, Ltd., 49 Queen Victoria St., London, E. C.—Cloth bound pamphlet describing the methods of working and the component parts of the "Universal" vertical engine.

J. E. H. Andrews & Co., Ltd., Reddish, nr. Stockport, England.—*(a)* Descriptive catalogue of the "Stockport" gas engine with illustrations and particulars of different sizes; also statement of advantages claimed; *(b)* latest price list of the Stockport gas engines.

Merryweather & Sons, Ltd., 63 Long Acre, London, W. C.—Illustrated catalogue and price list of the portable "Valiant" steam pumping engine, with description of its application to irrigation, mining, water supply, fire extinction and other purposes. Fully coded.

John Gordon & Co., 9 New Broad St., London, E. C.—Illustrated catalogue of colonial machinery for coffee, sugar, rice and other produce. Prices and particulars are given.

The Magnolia Anti-friction Metal Company, Ltd., 49 Queen Victoria St., London, E. C.—Perpetual calendar in red and gold for hanging on wall.